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DESIGN INTEGRATION TEST REQUIREMENTS - DYNA-SOAR

R. P. Tilbury, et al

Boeing Company

Prepared for:

Department of the Air Force

11 May 1962

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REVISIONS

May 11, 1962 Complete revision to establish sub-section format and update all requirements.

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REFERENCES

(1) Statement of Work, System 620A, Dyna-Soar for Contract AF33(657)-7132, Exhibit 620A-62-2, dated 26 January 1962

(2) Document No. D2-5697-16, Volume VI, Development Test Plan, Design Integration, Dyna-Soar

(3) MIL-E-6051C, Electrical - Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon Systems, Associated Subsystems and Aircraft

(4) MIL-I-26600, Interference Control Requirements, Aeronautical Equipment

INTRODUCTION

This document contains the design integration test requirements for the Dyna-Soar Program and shall serve as the official source for Project Section and Staff usage. The document is designed to provide a single point of reference for all design integration test requirements and shall be used in generating the development test plans to be shown in reference (2).

Design Integration Tests consist of engineering testing wherein system design variables are investigated to verify the physical and functional capability and compatibility of mated subsystems using hardware completely representative of production configuration.

These test requirements will be developed in successive levels of detail by first establishing the requirement on a broad basis, then developing in detail, reflecting design progress, to result in specific test requirements which will permit the preparation of detailed plans and procedures to be used for actual test conduct.

The document will be brought up-to-date as the need arises. Changes and/or additions to the requirements shall be submitted in writing to the Test Requirements Organization.

Requirements for each of the tests are documented in accordance with the following general format:

Title - An identification of the scope of testing requested.

Objectives - A statement of the major purpose for requesting the test, briefly delineating why the test is requested in a specific, stated area. Also a statement of the value and advantages expected to accrue from the test.

Configuration - A statement identifying the physical form of the test set-up. To include a listing of equipment, special test equipment and facilities required to accomplish the test.

Conditions - A description of conditions established as a requisite to the actual performance of the test. To include the test environment (pressure, temperature, vibration, weight, etc.), operational status of the subsystems, vehicle status, and the required functional and/or performance results to be obtained. Also a brief resume' of the operations and their sequence to be performed during the test.

Data Requirements - All data that is desired in the final test report is indicated. The data required consists of, but is not limited to:

1. Observations - the general and specific observations required to evaluate for satisfactory testing.

2. Measurements - all measurements and related information clearly defined so that the test objectives can be met by evaluation of the measurements requested. The following information is furnished:

INTRODUCTION (Continued)

a. Type of measurement (i.e., temperature, pressure, performance, errors, etc.)

b. Detailed locations of the measurement pick-up instrument or observer.

c. Anticipated min. - max. range limits of the measurement.

d. The overall measurement accuracy required, stated in terms of the measured variable.

Report Requirements - A description of the form and a listing of submittal dates for test reports. To include submittal procedures (routing, AF and NASA requirements, Associate Contractor requirements, etc.).

The following is a list of general ground rules for the tests described in this document.

1. Tests shall be performed and evaluated by skilled technicians and test engineers.

2. The Integrated Records System, as adapted to the Dyna-Soar program shall be used to provide a complete history of production and items used in Design Integration Tests.

3. The equipment which is to be integration tested shall be prototype operational or of production quality. Prototype equipment being that suitable for complete evaluation of form, design, and performance; utilizing approved parts and representative of the final production equipment with the exception of fabrication and tooling techniques, e.g., a formed or welded assembly vs. a forged or cast part. A prototype model follows experimental or developmental models (built to sketch type drawings) and precedes the production model.

4. Test equipment shall be calibrated with laboratory standards periodically.

5. Test points shall be provided to allow attachment of test equipment to each system without disturbing electrical or mechanical connections in the system.

6. Adequate inspection of mechanical features shall be provided.

7. Test requirements will generally apply to open-loop type of testing with direct operator interpretation of data. When closed-loop functions are to be monitored, automatic recorders and evaluation circuits shall be provided.

8. The test data will be used in support of the Human Factors, Maintainability, and Reliability Programs.

9. Departmental responsibilities for Dyna-Soar Design Integration Testing shall be in accordance with Dyna-Soar Operating Procedure 430-001.

1.0 GLIDER/TRANSITION SECTION

1.1 VERIFICATION TESTS This section contains the test requirements for verification testing as defined in Sections B(1.1.1.1.12) and B(1.1.1.1.13) of reference (1). The requirements are presented in four parts, 1) Structural Integrity, 2) Ground Vibration Survey, 3) Rigidity Verification, and 4) Acoustic and Vibration Environment. As an expedient in presenting these requirements and to aid in document maintainability each part is presented under separate sub-section title page.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE VERIFICATION TESTS - STRUCTURAL INTEGRITY

Section 1.1.1

The following section is being maintained by the Static Test Coordination Group of the Glider and Transition Design Section.

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DEVELOPMENT TEST REQUIREMENTS UNIT (DATE)

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SECTION TITLE PAGE

1.1.1 STRUCTURAL INTEGRITY VERIFICATION TEST REQUIREMENTS

1.1.1.1 GLIDER/TRANSITION NON-DESTRUCTIVE STATIC TEST REQUIREMENTS It is required to verify that the glider will withstand the design ultimate loads in the major configurations of boost, flight, and landing at the temperatures associated with the critical conditions, without failure. Furthermore, the structural integrity of the glider must be verified under these conditions after the following thermal exposures. (a) Four (4) thermal exposures are required prior to subjecting the vehicle to the 95% of Design Ultimate Loads of flight and landing conditions. (b) Three (3) thermal exposures are required prior to application of the 95% D.U.L. of boost conditions. The glider will actually be exposed to four (4) thermal cycles prior to application of the boost test conditions to avoid changing the test set up unnecessarily. It has been determined that the structure will not be harmed by the extra heat cycle.

1.1.1.1.1 Test Objectives The objective of the static tests is to verify the structural integrity of the Dyna-Soar glider by subjecting the three major configurations to the design ultimate loads at the temperatures associated with the critical conditions. Verification will be obtained by testing the vehicle to 95% of Design Ultimate Load and extrapolating the data obtained to 100% D.U.L. Where extrapolation indicates failure before 100%, the structure will be reviewed for possible reinforcement.

1.1.1.1.2 Test Configuration

1.1.1.1.2.1 Test Hardware - The same complete glider shall be used for each of the three basic configurations of flight, boost, and landing experienced during a mission profile. Deviations from an actual flight article are listed below:

1. Airframe - The airframe will be identical to the actual flight article except that the nose cap will be omitted, but the nose cap support ring and the radiation baffle at approximately Sta 127 will be installed.

2. Secondary Power Subsystem - All components of the secondary power subsystems will be deleted with the exception of the following:

   a. Geometrically and thermally simulated accessory power units will be installed.

   b. Electrical power distribution high temperature wiring will be installed.

   c. Hydraulic service panel and transmission lines will be installed.

   d. Simulated control surface actuation will be installed. The actuators must allow full movement of aerodynamic surfaces and flow of cooling hydraulic fluid identical to that of operational actuators.

   e. Geometrically and thermally simulated reaction control transmission lines, nozzles, and valves will be installed.

   f. High pressure pneumatic windshield cover jettison and landing gear extension systems will be installed except for gas bottles. The actuators may be simulated if production items are not available.

1.1.1.1.2.1 (Continued)

3. Environmental Control System - All components of the environmental control system will be deleted with the exception of the following:

   a. The water wick panels will be replaced by special test equipment employing panels cooled by a circulating fluid.

   b. Special test equipment will be used to cool and circulate hydraulic fluid through the actuators and hydraulic tubing located outside of the cooled compartments.

4. Glider Primary and Secondary Flight Control - Delete entire system.

5. Primary Vehicle Guidance Subsystem - Delete entire system.

6. Glider Flight Instruments - Delete entirely.

7. Communication and Tracking - Delete entire system.

8. Fire Protection - Safety - Personnel Protection - Delete entire systems.

9. Delete all avionics equipment except for Antennas, Windows, and Feedlines. Antennas, windows, and feedlines will be installed for the C-band tracking beacon, voice/data command receiver, FM/FM data system, PCM/FM data voice system and the search and rescue system.

10. All flight instrumentation will be omitted from the static test article except that flight test wire bundles will be simulated where thermal effects are significant.

11. Fittings will be incorporated in design and fabrication of the static test glider for applying loads and reactions, attaching deflection indicator rods or wires, and supporting instrumentation wiring. The load fittings will generally be located at the truss joints, along the leading edge beams, at control surface and fin ribs, control surface hinge points and compartment and equipment support points. Consideration will also be given to load fittings within and on the crew and equipment compartments. Some load fittings must provide for applying loads parallel to the longitudinal axis as well as normal to it.

12. Holes through surface panels will be provided where required to pass load cables, rods, or straps. Consideration will be given to sealing off the resulting gaps.

13. A pressurized and cooled hydraulic fluid system will be required for the hydraulic actuators.

In addition, a transition section as described in Paragraph 1.1.1.3.2 will be attached to the boost configuration glider.

1.1.1.1.2.2 Test Hardware Mounting

1. Boost Configuration - The glider will be attached to a glider/booster transition section plus approximately 2 feet of simulated booster structure. This configuration will be cantilevered off a strong back for all tests.

2. Flight Configuration - The flight configuration has several versions such as low drag, high lift, and landing approach. In all flight configurations the glider will be suspended by the loading system and stabilized and balanced by the reaction system, all of which will allow the structure to deflect as the loads and heat are applied.

3. Landing Configuration - The glider will be loaded through the landing gear and balanced by the loading system simulating inertia loads and airloads.

1.1.1.1.3 Test Conditions

1.1.1.1.3.1 Summary - This general division of tests requires a complete glider in the three basic configurations experienced during a mission profile: boost, flight, and landing. The glider/booster transition section will also be required in the boost configuration. The non-destruction category refers to the fact that no test condition will exceed 95% of Design Ultimate Load (D.U.L.).

In general these tests will be conducted at two different test temperatures: room temperature, and design temperature on lower surface Rene' 41 panels.

At room temperature, the programmed test loads (67% D.U.L.) will be applied on each configuration, and stresses in the various members will be determined. These room temperature tests duplicate the boost and landing conditions and the loading of the flight conditions. They will provide stresses at locations that can be instrumented only as subassemblies. Since the strain gages will be lost during high temperature tests, the load-only flight condition tests will aid in estimating stresses for the high temperature design test conditions.

High temperature tests will be conducted on the flight configuration. The glider will be exposed to four identical time-temperature cycles simulating the thermal effects of four complete "once around" missions. Externally applied peak loads of 67% D.U.L. for each of the critical hot conditions will be used during the exposure cycles. A load of 1 g will be applied during the four thermal exposures except during the application of the test condition loads. After completion of the four exposure cycles the boost and landing load tests to 95% D.U.L. will be conducted. Finally, the flight condition tests will be conducted at 95% D.U.L. under re-entry thermal environment.

1.1.1.1.3.2 Test Outline - The sequence of testing for the non-destruction glider static tests is listed below. These tests will be discussed in detail in the following paragraphs.

1. Pylon Loads - Load Only

2. Flight Configuration - Load Conditions to 67% D.U.L.

3. Landing Configuration - Load Conditions to 67% D.U.L.

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1.1.1.1.3.2 (Continued)

4. Boost Configuration - Load Conditions to 67% D.U.L.

5. Flight Configuration - Heat and Load to 67% D.U.L.

6. Boost Configuration - Load Conditions to 95% D.U.L.

7. Landing Configuration - Load Conditions to 95% D.U.L.

8. Flight Configuration - Heat and Load to 95% D.U.L.

1.1.1.1.3.3. Flight Configuration - Test 1: (B-52) Pylon Loads - Load Only

Data will be presented as it becomes available.

1.1.1.1.3.4 Flight Configuration - Test 2: Load Only Conditions to 67% D.U.L., Test 5: Heat and Load Conditions to 67% D.U.L., Test 8: Heat and Load Conditions to 95% D.U.L.

Test 2 will be conducted at room temperature to 67% of design ultimate load. In test 5 the glider will be exposed to 67% of D.U.L. at appropriate member temperatures. In test 8, the glider will be loaded to 95% of critical design ultimate loads at appropriate member temperatures. Temperatures and deflections will be recorded throughout the test and control surface movement will be checked at 67% of design ultimate loads. Load calculations will be based on the flight conditions listed below.

1. Balanced Positive Pitch Maneuver at 171,000 Feet Altitude - This maneuver is critical for the spar carry-through chords and drag braces.

Altitude	= 171,000 feet
Velocity	= 12,500 fps
Ultimate Load Factor N_Z	= 7.5
Angle of Attack	= 54°
Temperatures:	
Spar Carry-through Chords	= 1600°F to 1750°F
Wing Members	= 1125°F maximum
Wing Lwr. Surf. Corr. Superalloy	= 1460°F Fwd of B.S. 300
Wing Lwr. Surf. Corr. Superalloy	= 1360°F Aft of B.S. 300
Body Lwr. Surf. Corr. Superalloy	= 1780°F Fwd of B.S. 299
Body Lwr. Surf. Corr. Superalloy	= 1760°F Aft of B.S. 299

2. Balanced Positive Pitch Maneuver at 29,000 Feet Altitude - This maneuver is critical for some aft wing members and all members of the forward wing including the leading edge beam.

Altitude	= 29,000 feet
Velocity	= 1,100 fps
Ultimate Load Factor	= 11.0
Angle of Attack	= 13.2°
Temperatures:	
Aft Body Members	= 650 to 900°F
Fwd Body Members	= 700 to 950°F
Aft Wing Members	= 500 to 600°F

1.1.1.1.3.4 (Continued)

2. (Continued)

Fwd. Wing Members	= 500 to 600°F
Wing Lwr. Surf. Corr. Superalloy	= 600°F

3. Roll Maneuver at 29,000 Feet Altitude - This maneuver is critical for the spar carry-through diagonals, aft body frame members, some aft wing members, and the rudder.

Altitude	= 29,000 feet
Velocity	= 1,100 fps
Ultimate Load Factors N_z	= 2.25, N_x = -1.8, N_y = -1.5
Angle of Attack	= 3.8°
Temperatures:	
Spar Carry-through Diagonals	= 995°F maximum
Lwr Body Frame Members	= 1025°F maximum
Aft Wing Members	= 775°F maximum
Wing Lwr. Surf. Corr. Superalloy	= 350°F
Body Lwr. Surf. Corr. Superalloy	= (Sta. 158) = 800°F

4. Yaw Maneuver - This maneuver is critical for the fin and rudder.

Altitude	= 138,000 feet
Velocity	= 9,000 fps
Ultimate Load Factor N_z = 2.34, N_x	= -0.45, N_y = 1.26
Angle of Attack	= 15.5°
Yaw Angle	= 20°
Rudder Deflection Angle	= 30°
Temperatures:	
Fin Surface	= 1970°F maximum
Rudder Surface	= 2500°F maximum
Lwr. Body Truss Diagonals	= 1625°F maximum

5. Yaw Maneuver - This maneuver is critical for the fin, rudder and some aft wing members.

Altitude	= 29,000 feet
Velocity	= 1,100 fps
Ultimate Load Factor N_x = 2.1, N_y	= -2.22, N_z = 1.58
Angle of Attack	= 2°
Yaw Angle	= -10°
Temperature:	
Fin and Rudder	= data unavailable
Aft Wind Truss Members	= 500° - 600°F

6. Yaw Maneuver - This maneuver is critical for the body diagonals forward of B.S. 388.5.

Altitude	= 29,000 feet
Velocity	= 1,100 fps
Ultimate Load Factor N_z = 1.73, N_y	= 2.02, N_x = -0.83
Angle of Attack	= +1°
Yaw Angle	= 9°

1.1.1.1.3.4 (Continued)

6. (Continued)

Temperature:
Lower Body Truss Diagonals = 995°F

7. Pitch Initiation - This condition is critical for elevon and tab actuator support structure in the aft wing.

Altitude	= 29,000 feet
Velocity	= 1,100 fps
Ultimate Hinge Line Moment	= 383,000 in-lb.
Temperatures:	
Actuator support structure	= 600°F maximum
Lower surface corrugated super-alloy	= 600°F

1.1.1.1.3.5 Landing Configuration - Test 3: Load Conditions to 67% D.U.L., Test 7: 95% D.U.L.

The glider will be loaded to 67% D.U.L. for test 3, and 95% of design ultimate loads for test 7 at room temperature during these tests. Strains and deflections will be recorded throughout the tests. Load calculations will be based on the landing conditions indicated in the following paragraphs.

1. High Speed Yaw - Roll Landing - After Escape - This condition is critical for the main landing gear support structure.

Velocity	= 225 knots
Angle of Attack	= 5°
Yaw	= 10°
Roll	= 5°
Sink Rate	= 10 fps
Temperature	= 70°

2. Low Speed Symmetric Landing After Escape - This condition is critical for the nose landing gear support structure, body structure forward of Station 202, and the body vertical and side diagonal members forward of Station 299.

Velocity	= 140 knots
Angle of Attack	= 15°
Yaw	= 0°
Sink Rate	= 10 fps
Temperature	= 70°F

1.1.1.1.3.6 Boost Configuration - Test 4: Load Conditions to 67% D.U.L., Test 6: Load Conditions to 95% D.U.L.

During tests 4 and 6 the glider will be loaded to 67% and 95% of critical design ultimate loads respectively at room temperature. Strains and deflections will be recorded throughout the test. Load calculations will be based on the flight conditions indicated in the following paragraphs. Test 4 conditions will be imposed before and test 6 conditions after the four thermal exposures.

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1.1.1.1.3.6 (Continued)

1. Positive Bending - Wind Shear Plus Gust--This condition is critical for the upper body main and diagonal side truss members aft of station 202 and some aft wing members.

Altitude	= 32,500 feet
Velocity	= 1,170 fps
Ultimate Load Factor N_z	= 0.69
Angle of Attack	= +5.9°

2. Negative Bending-Wind Shear Plus Gust--This condition is critical for body lower main side truss and diagonal members aft of Station 234.

Altitude	= 32,500 feet
Velocity	= 1,170 fps
Ultimate Load Factor N_z	= -0.69
Angle of Attack	= -5.9°

1.1.1.1.3.7 Load Application - Load application will be to the load points through an evener system by hydraulic jacks in such a manner that the required shears, bending moments, and torsions will be produced. The loads will be applied by cables, straps, rods, or combinations thereof, attached to fittings or tabs provided at the various load points. For the flight configurations, the reactions will also be provided by cables, straps, or rods. Magnitude of loads shall be sensed by dynamometer bars.

1.1.1.1.3.8 Heat Application - Heat application will be to the exterior surfaces of the glider by banks of radiant heat lamps. Each bank of lamps will be controlled so as to obtain the design temperatures on the superalloy portion of the lower surfaces of fuselage, wing, fin, and control surface skin panels, on the side panels of the fin and rudder, and on certain superalloy portions of the leading edge beams. Monitoring thermocouples will be located on the outermost surface of insulated panels and leading edge segments. Because thermal properties of the insulation vary with atmospheric pressures, the programmed test temperature of the outermost surface of insulated panels and leading edge segments will not necessarily be the same as their design temperatures. Analysis and test development will be required to establish the thermal relationship between the outer surfaces and the superalloy portions of the insulated panels and leading edge beams. Provision will be made for standby control thermocouples such that they can be individually switched into the control circuit at any time.

1.1.1.1.3.9 Heat and Load Conditions - Heat and load conditions at high temperatures will proceed as follows: An (L/D) max, 45° bank equilibrium glide re-entry thermal exposure will be imposed on the vehicle under a one "g" load. The test condition will be imposed after the maximum temperature has been attained. The test temperature will be reduced per the (L/D) max, 45° bank equilibrium glide trajectory, to the controlled structural temperature required during application of the test load. The load will then be applied at a uniform rate until limit load is reached. This limit load will be held until the control surfaces are checked for free movement and/or interference.

When loading to 95% of D.U.L. the loading will be increased at a uniform rate until the test load is reached. This maximum load will be held until all instrumentation is recorded. Then the load will be decreased to zero at a uniform

1.1.1.1.3.9 (Continued)

rate. Finally, the temperature will be reduced to room temperature. One or more load conditions may be imposed during a re-entry thermal exposure. In any case only four re-entry exposures each will be imposed during tests 5 and 8.

1.1.1.1.4 Data Requirements

1.1.1.1.4.1 Stress Measurements - Stress measurement on the primary glider structure will be made by electrical strain gages. For each test employing gages, the critical ones will be visually monitored and recorded at the maximum frequency rate of the automatic data acquisition system. Approximately 500 strain gages will be installed during glider construction. These gages will be used before any high temperature tests are conducted. Certain accessible gages will be reinstalled after thermal exposure tests have been conducted.

1.1.1.1.4.2 Temperature Measurements - Temperature measurement throughout the glider will be performed by thermocouples. Temperature of a single strain gage or a cluster of strain gages will be determined by an adequate number of thermocouples. Critical thermocouples will be visually monitored. All thermocouples, including control thermocouples, will be automatically recorded by the data acquisition system at a sampling rate varying from intervals of two seconds to 120 seconds. Thermocouples will be required to handle temperatures up to 300°F on aluminum alloy, 2100°F on thin gage superalloy, and 2800°F on coated Moly. Approximately 600 monitoring and recording thermocouples will be used. The control thermocouples and stand-by control thermocouples required will be determined by the lamp bank arrangements.

1.1.1.1.4.3 Deflection Measurements - Deflection measurements will be made by electrical deflection indicators or other satisfactory means. They will be monitored and recorded in the same manner as the critical strain gages. The deflections will also be recorded at the maximum frequency throughout the "hot" tests. Approximately 80 to 120 deflection indicators will be used on the static test glider.

1.1.1.1.4.4 Photographs - Adequate still photographs, chiefly in black and white but with some 35mm color slide shots, will be required. Motion pictures of certain test phases will also be required.

1.1.1.1.5 Report Requirements To be inserted when available.

1.1.1.1.6 Facility and Equipment Requirements

Automatic Data Recording System - This system has to be capable of recording 600 thermocouples, 500 strain gages and 120 electronic deflection indicators. A minimum of 200 thermocouples should be monitored visually.

Dynamometer Bars
Load Monitoring Records
Load Evener System
Hydraulic Jacks

Radiant heat lamps and associated equipment required to handle temperatures up to 300°F on aluminum alloy, 2100°F on thin gage superalloy, and 2800°F on coated Moly. The fixtures supporting the lamps and cooling system must be easily and

1.1.1.1.6 (Continued)

quickly removable to provide inspection access to the exterior glider surfaces.

Test jig or strongback capable of supporting the test specimen and reacting the loads that would be transferred from the glider truss structure through the transition and a 2-foot section of simulated booster structure into the strongback.

Floor rails or reaction points adjacent to the strongback to react applied test loads.

An overhead crane to position the test hardware on the strongback and to handle test equipment.

Provisions for taking 35mm color slides, color and black and white motion pictures, and 4 x 5 (minimum) color, and black and white stills.

One-hundred and twenty (120) deflection indicators with range variable up to ± 5 inches.

Load and heat program equipment

Actuator and waterwall cooling equipment

Overhead jig and frame structure

1.1.1.2 GLIDER/TRANSITION STRUCTURAL COMPONENT TESTS Certain components that have a structural entity of their own and whose supporting structures provide relatively simple reactions will be tested apart from the glider. This approach will shorten the total test time by permitting preparation for total glider tests during the set-up, facilities check-out, and actual test of components. It will also permit destruction testing of the components without the danger of premature failure of the primary glider structure at or near the component support points.

The following component tests will be done at Boeing:

1. Pilot's Compartment
2. Equipment Compartment
3. Hatches, Doors, Windows and Windshield Cover
4. Skin Panels
5. Leading Edge Segments
6. Structural Joints not adequately verified in glider static tests
7. Structural Assemblies not adequately verified during glider static tests

1.1.1.2.1 PILOT'S COMPARTMENT TEST REQUIREMENTS In order to verify the structural integrity of the Dyna-Soar glider, it is required to verify the structural integrity of the pilot's compartment at the limit loads and associated temperatures and up to the ultimate loads and associated temperatures.

These tests will include internal pressure load conditions as well as point load conditions simulating inertia forces. See paragraph 1.1.1.2.1.3. Internal pressure will be obtained by compressed gas at temperatures of 60° to 160°F inclusive. The gas may be air, nitrogen or carbon dioxide.

1.1.1.2.1.1 Test Objectives The objectives of these tests will be to apply loads and temperatures simulating as closely as possible the critical design conditions itemized in paragraph 1.1.1.2.1.3. The tests will verify the structural integrity of the pilot's compartment by demonstrating that failure will not occur at less than the ultimate loads and associated temperatures of the critical design conditions.

1.1.1.2.1.2 Test Configuration A structurally complete pilot's compartment from the static test glider will be required including all components carrying internal pressure loads such as hatches and windows. It will contain the supports for the ejection seat rails, the rails for the seat, and a simulated seat.

The compartment will have the following modifications:

1. An inlet fitting will be provided in the compartment wall to receive the pressurizing gas.

2. Wherever feasible, load fittings will be incorporated directly into the compartment structure. Where not feasible, load tension pads will be employed.

3. Deflection points will be provided with "built-in" tabs.

4. All non-structural internal equipment will be omitted.

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1.1.1.2.1.2 (Continued)

The compartment will be tested while supported by a fixture described briefly in paragraph 1.1.1.2.1.6 and will be so oriented with respect to the vertical and horizontal as to simplify as much as possible the point loading, internal pressure loading, heating, and data instrumentation.

1.1.1.2.1.3 Test Conditions

1. Stress-coat survey pressure only at room temperature.

2. Boost at room temperature with critical combined thrust and transverse acceleration to 95% D.U.L.

3. Seat ejection at room temperature to 100% D.U.L.

4. Maneuver at room temperature with critical vertical accelerations to 95% D.U.L. Heat will be applied to those surfaces on which environmental tests indicate a significant temperature rise.

5. Maneuver at design temperature of 1750°F with critical vertical accelerations to 95% D.U.L.

6. Negative internal pressure at room temperature to 95% D.U.L.

7. Positive internal pressure at room temperature to 100% D.U.L.

The general outline of the stress-coat survey test will be as follows:

1. Apply stress-coat to both outer and inner surfaces of the structural shell at selected areas adjacent to windows, hatches, and cutouts.

2. Load with internal pressure by increments. Remove pressure after every increment to observe the stress-coat on the inside of the compartment.

3. Record deflections of selected locations at each increment of load.

4. The maximum pressure applied will be 75% of the proof pressure load. This applied maximum pressure for the stress-coat is approximately 7.2 psig.

Following this, strain gages will be installed. Then, room temperature tests combining internal pressure and point loads, or point loads only, will be conducted by applying increments of load at uniform and moderate rates. Point loads will be applied by hydraulic jacks through an evener system and cables, rods or straps to tabs provided at the various load points. The point loads will be reacted by the fixture described in paragraph 1.1.1.2.1.6. Appropriate data will be taken at varying time intervals.

Next, the critical combined load and temperature tests will be conducted. These tests will consist of applying heat where required to obtain a temperature rise rate not to exceed 5°F per second. Local cooling and/or insulation will be employed to provide thermal protection for the compartment's structural shell in the vicinity of the compartment fittings. After temperatures have been

1.1.1.2.1.3 (Continued)

stabilized at the required values, loads will be applied at a uniform rate until limit load is reached. While load is held at this plateau for two (2) minutes, deflection and stress data will be taken at ten (10) second intervals.

The loading will then be increased uniformly until 95% or 100% of D.U.L. is reached. This load will be held until deflections are recorded. Then the load and heat will be decreased to zero uniformly.

Next the compartment will be subjected to eight operating pressure cycles. Following this, the critical maneuver acceleration loads to 95% D.U.L. will be applied to the compartment while it is unpressurized. All tests will be at room temperature. Stresses, deflections, and photographs will be taken throughout the test.

1.1.1.2.1.4 Data Requirements Pressure, strain, deflection, and temperature measurements and stress-coat observations will be required.

1.1.1.2.1.5 Report Requirements To be inserted when available.

1.1.1.2.1.6 Facility and Equipment Requirements Pilot's compartment tests will be conducted at Boeing. A typical static test area approximately fifteen feet square will be required. However, during pressure tests, barriers will be required to convert the area into a hazardous test site capable of protecting personnel and adjacent equipment. Techniques will be employed to reduce the energy stored in the compartment during pressure tests. Standard facilities for applying point loads and heat and taking data at frequent intervals will be required. A source of moderate pressure and temperature gas will be required. See paragraph 1.1.1.2.1.3. It must be capable of maintaining an internal compartment pressure of up to psig (pressure to be determined but estimated at 16 psig maximum) with a compartment leakage rate of 10 cubic feet per minute.

a. A jig to support and react the point loads applied to the compartment. The jig will simulate the support points on the glider and be designed with a minimum factor of safety of three (3) on the critical design ultimate compartment reactions. The design will also account for the effects of temperature.

b. Fixtures to support heat lamps and deflection transducers. The heat lamps and supporting framework will be designed for simple removal to permit adequate inspection access.

c. An adaptor to connect the pressurized gas line to the special inlet fitting provided on the compartments.

d. A supply of cooling fluid and pumps and associated equipment comprising a system to circulate the fluid through the special cooling devices which will provide local thermal protection for the compartments structural shell.

1.1.1.2.2 EQUIPMENT COMPARTMENT TEST REQUIREMENTS To be inserted when available.

1.1.1.2.3 HATCHES, DOORS, WINDOWS & WINDSHIELD COVER TEST REQUIREMENTS To be inserted when available.

1.1.1.2.4 SKIN PANELS TEST REQUIREMENTS To be inserted when available.

1.1.1.2.5 LEADING EDGE SEGMENTS TEST REQUIREMENTS To be inserted when available.

1.1.1.2.6 STRUCTURAL JOINTS TEST REQUIREMENTS To be inserted when available.

1.1.1.2.7 STRUCTURAL ASSEMBLIES TEST REQUIREMENTS To be inserted when available.

1.1.1.3 GLIDER/BOOSTER TRANSITION TEST REQUIREMENTS In order to verify the structural integrity of the Dyna-Soar vehicle, it is required to verify the structural integrity of the glider/booster transition section and of the acceleration rocket motor supports at 95% of design ultimate loads.

1.1.1.3.1 Test Objectives The purpose of this static test is to verify the structural integrity of the glider/booster transition and the acceleration rocket motor supports. This objective shall be met by exposing the structure to 95% of design ultimate loads (D.U.L.) without failure.

1.1.1.3.2 Test Configuration The static test glider/booster transition shall be of structurally complete flight quality hardware and identical to an actual flight article except as noted below:

1. No ablative coating will be installed.

2. A spent acceleration rocket motor from the PFRT program shall be used.

3. Separation devices shall be inactivated.

4. Fittings will be incorporated in the design and fabrication of the test article for applying loads and reactions, for attaching deflection indicators, and for installation of other required equipment.

5. Holes through the surface panels will be provided where necessary to pass load cables, rods, and straps.

Conditions 1 and 2 will be tested with the transition mounted on the complete glider during glider tests 4 and 6. For conditions 3 through 9, the forward section of the transition shall be mounted to a 3 to 5 foot section of the glider aft truss structure or a structurally simulated truss structure.

The glider/booster transition shall be mounted between the simulated glider structure and 2 foot section of simulated booster structure. The entire test specimen shall be cantilevered off a "strong back". The booster portion shall connect the test specimen to the "strong back".

1.1.1.3.3 Test Conditions

1. Maximum positive bending to 67% and 95% D.U.L. (Glider Tests 4 and 6 respectively, see Paragraph 1.1.1.3.6).

2. Maximum negative bending to 67% and 95% D.U.L. (Glider Tests 4 and 6 respectively, see Paragraph 1.1.1.3.6.)

3. Maximum side bending to 95% D.U.L.

4. Combined side and positive bending to 95% D.U.L.

5. Combined side and negative bending to 95% D.U.L.

6. Maximum torsion condition to 95% D.U.L.

7. Maximum acceleration condition to 95% D.U.L.

1.1.1.3.3 (Continued)

8. Abort at maximum pitch bending + thrust vector control.

9. Abort at maximum yaw bending + thrust vector control.

The transition will be tested for conditions 1 and 2 during glider tests 4 and 6 per Paragraph 1.1.1.1.3.6. Conditions 3 through 9 do not require the glider. Simulated glider structure as noted in 1.1.1.3.2 may be used.

Loads will be applied to the load points through an evener system by hydraulic jacks in such a manner that the required shears, bending moments, and torsions will be produced. All loads will be applied to 95% D.U.L. Heat will be applied by banks of radiant heat lamps during test 7. Each bank of lamps will be controlled by a thermocouple to limit the internal skin temperature to 300°F.

1.1.1.3.4 Data Requirements Stresses on the primary transition structure will be measured by electrical strain gages. For each test employing gages, the critical ones will be visually monitored and recorded at the maximum frequency rate of the automatic data acquisition system. Electrical deflection indicators will be used to measure deflections. They will be monitored and recorded in the same manner as the critical strain gages.

1.1.1.3.5 Report Requirements To be inserted when available.

1.1.1.3.6 Facility and Equipment Requirements

Dynamometer Bars
Load Monitoring Recorders
Load evener system
Hydraulic jacks
Test jig or strongback capable of supporting the test specimen and reacting the loads that would be transferred from the glider truss structure through the transition and into the booster portion.

Floor rails or reaction points adjacent to the strongback to react applied test loads.

An overhead crane to position the test hardware on the strongback and to handle test equipment.

Automatic data recording system.

Radiant heat lamps and associated equipment required to handle temperatures up to 300°F on the aluminum alloy skin of the glider/booster transition structure.

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TITLE VERIFICATION TESTS - GROUND VIBRATION SURVEY

(Glider Dynamic Test) Section 1.1.2

The following section is being maintained by the Design Integration Test Requirements Group of the Systems Engineering Section.

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The following persons have made significant contributions to the preparation of this section:

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1.1.2 GROUND VIBRATION SURVEY (GLIDER DYNAMIC) TEST REQUIREMENTS

A ground vibration test of the Dyna-Soar glider shall be conducted to verify the structural integrity of the Dyna-Soar glider. The test shall be conducted in two phases; (1) a hard mount test to verify the glider control surfaces vibration modes, frequencies, and damping values; and (2) a soft mount test to verify the vibration modes, associated frequencies, and damping values of the complete glider.

1.1.2.1 FLIGHT CONTROL SURFACES TEST REQUIREMENTS (HARD MOUNT)

1.1.2.1.1 Test Objectives The purpose of this glider ground vibration test is to measure the natural modes, frequencies, and damping of the flight control surfaces in order to verify those values used in glider flutter calculations and dynamic loads studies. It shall also be required to detect local resonances that may affect the glider operation in order that corrective redesign may be effected.

1.1.2.1.2 Test Configuration A complete glider shall be mounted so that:

1. The glider body is rigidly attached to the ground at the aft end, a forward point, and at least one place in between.
2. The aft wing spar is rigidly attached to the ground at two or more points including the wing tip. The wing fin crease spar is rigidly attached to the ground at the fin attachment point.
3. The elevons are complete with the proper mass properties. They are servo-locked at zero degrees and 75% of maximum up and down positions.
4. The rudders are complete with the proper mass properties. They are servo-locked at 10% and 75% of maximum travel.

All primary and secondary structure of the glider shall be flight quality. Equipment necessary to activate and servo-lock the control surfaces shall be operable.

The flight motion sensors and power to activate the sensors shall be installed. Body weight conditions are not critical so that body skin panels may be removed. Wing skin panels may also be removed to facilitate glider attachment in the configuration described.

1.1.2.1.3 Test Conditions Each of the flight control surfaces described in paragraph 1.1.2.1.2 shall be vibration tested to determine the natural frequency of the surfaces in rotation about their respective hinge lines. A vibrator shall be used to vibrate the surface with a constant force throughout the frequency range of 0.5 to 100 cps and an accelerometer shall be used to record the amplitude of response of the surface. The maximum response defines the natural frequency. Effects of non-linearity shall be studied by repeating the procedure at several force levels.

Detail test conditions will be included at a later date.

1.1.2.1.4 Data Requirements

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Instrumentation:

- Fifteen (15) linear and two (2) angular accelerometers
- Four (4) force gages
- Four (4) phase meters
- Recording Equipment

1.1.2.1.4 (Continued)

Data Reduction System:

A high speed digital data reduction system to process raw data and calibration curves to present mode shapes, frequencies, and damping values in tabulated form shall be required.

1.1.2.1.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

1.1.2.1.6 Facility and Equipment Requirements

Vibration Test Equipment:

Four (4) 15# to 25# peak force vibrators for control surfaces.
Electronic amplifiers to drive vibrators.
A control panel to control phase (0° to 180°) and amplitude of each vibrator individually.

1.1.2.2 FLIGHT CONFIGURATION TEST REQUIREMENTS (SOFT MOUNT)

1.1.2.2.1 Test Objectives The purpose of this glider ground vibration test is to measure the coupled modes of the complete glider, and the associated frequencies and damping in order to verify those values used in glider flutter calculations and dynamic loads studies; also to verify the Flight Control Subsystem performance, including Flight Control Subsystem Electronics, under simulated inputs and simulated flight conditions, with and without the transition section attached. The purpose of this test is also to determine the vibration characteristics of the pressure compartments and large equipment items. In addition, it shall be required to detect local resonances that may affect the glider operation in order that corrective redesign may be effected.

1.1.2.2.2 Test Configuration The complete glider shall be soft mounted in such a way that the frequencies of all rigid modes (vertical, side, and longitudinal translation; pitch, roll and yaw) are less than 0.75 cps. A davit and spring suspension system is desired, although another system such as air bags may be used.

All primary and secondary structure of the glider shall be flight quality. All hardware in the vicinity of the pre-selected flight motion sensor locations, or alternate locations if any, shall be flight quality.

All access doors shall be properly installed or shall be replaced with test doors.

Equipment necessary to activate and servo-lock the control surfaces shall be operable.

The flight motion sensors and power to activate the sensors shall be installed.

All equipment not included in the vehicle shall be replaced by dummy equipment with correct weights, center of gravity and attachments.

1.1.2.2.3 Test Conditions The vehicle shall be scanned through the frequency range of 0.5 to 250 cps to determine all coupled modes. Vibrator combinations shall be used to accurately establish each coupled mode. Frequency, phases, damping, and deflections of these modes shall be measured.

The following test conditions shall be used:

1. Maximum glider weight with forward glider/booster transition section and inert maximum weight Acceleration Rocket Motor (ARM) attached.
2. Glider with forward glider/booster transition section and empty ARM (burnout configuration) attached.
3. Glider without glider/booster transition. Control surface actuation unlocked; Flight Control Subsystem operative and servo-locked.
4. Glider without glider/booster transition. Control surface actuation unlocked; Flight Control Subsystem, including Flight Control Subsystem Electronics, operative.
5. Glider without glider/booster transition. Control surface actuation mechanically locked; flight control subsystem electronics off.

1.1.2.2.4 Data Requirements Data shall be obtained for motions in the pitch, roll, yaw, longitudinal, vertical and lateral directions. Mode deflections shall be measured on the body, wings, elevons, fins, pressure compartments, APU, and cryogenic tanks.

Instrumentation Range:

1. 0 to 350 cps
2. 0 to 5 g's

Instrumentation:

A. Accelerometers will be used to measure the dynamic response of the vehicle. A total of 60 linear and 2 angular accelerometers will be required, located approximately as follows:

   1. Body - 6 linear
   2. Wings - 9 linear
   3. Fin and rudders - 9 linear
   4. Elevons - 4 linear, 2 angular
   5. Equipment Bay - 9 linear
   6. Pilot Compartment - 9 linear
   7. Cryogenic Tanks and APU - 12 linear
   8. Spares - 2 linear

   Low-pass filters, readily adjustable between 1 and 400 cps, are required for all tape recorder inputs and on the force signal input.

B. Mechanical Impedance Gages - Force gages to measure the dynamic force input from the shakers will be required - 10 required.

C. Flight Motion Sensor Equipment - Flight type sensors will be used to determine open loop transfer functions through the vehicle structure.

D. Phase meters - Record various control subsystem Electronic phase relationships - 6 required.

E. Record various Flight Control Subsystem Electronic Signal amplitudes in conjunction with D above.

F. Recording Equipment

   1. The data shall be recorded in sequenced groups on a tape recorder for use with a digital data reduction system - 1 recorder required. Tape recorder channels with associated instrumentation shall be phase-matched to $\pm$ 5° at 350 cps.

   2. A limited amount of accelerometer outputs will be recorded on a direct read-out recorder as required for quick-look data (12 channels required).

   3. Accelerometer outputs will be displayed on oscilloscopes, phased one against another, as required, through a switching arrangement - 3 scopes required.

   4. Accelerometer output will be displayed on vacuum tube voltmeters or RMS meters at the same time as on oscilloscopes - 6 meters required.

1.1.2.2.4 (Continued)

Data Reduction System:

A high speed digital data reduction system to process raw data and calibration curves to present mode shapes, frequencies, and damping values in tabulated form shall be required.

1.1.2.2.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

1.1.2.2.6 Facility and Equipment Requirements

Vibration Test Equipment:

Six (6) 150# peak force vibrators for the wing and body.
Four (4) 15# to 25# peak force vibrators for control surfaces.
Electronic amplifiers to drive vibrators.
A control panel to control phase (0° to 180°) and amplitude of each vibrator individually.

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TITLE VERIFICATION TESTS - RIGIDITY VERIFICATION

Section 1.1.3

The following section is being maintained by the Static Test Coordination Group of the Glider and Transition Design Section.

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1.1.3 RIGIDITY VERIFICATION TEST REQUIREMENTS In order to verify the structural integrity of the Dyna-Soar glider, it is required to verify glider influence coefficients. This test is required prior to the start of the glider non-destruction static tests called out in Section 1.1.1.1.

1.1.3.1 Test Objectives The purpose of measuring influence coefficients on the glider is to verify the results of theoretical calculations of these influence coefficients. Since influence coefficients are a basic input for calculating natural modes, frequencies and load deflections, a study of these coefficients can best explain any discrepancies between calculated modes and measured modes.

1.1.3.2 Test Configuration The test vehicle shall be a structurally complete glider without the glider/booster transition. The glider shall be attached to a structural test "strong back" at the four transition attach points. Attachment shall be such as to minimize deflection of these attach points in all directions. Glider fins are required, but rudders, elevons, landing gears, etc. are not.

Equipment, if it is not a structural component, is not required.

Fixtures for attaching loads at each truss joint designated for influence coefficients will be required to be built into the test vehicle. Holes through surface panels will be provided where required to pass load cables, rods, or straps.

1.1.3.3 Test Conditions Measure deflections in the glider pitch and yaw planes at truss joints, as shown in Figure 1.1.3-1 for loads applied as follows:

1. The loading points are shown in Figure 1.1.3-1.

2. Pitch - Load points designated with common letters equally and simultaneously in the same direction and then in opposite directions about the longitudinal centerline. Load points with different letters separately, taking all deflection data for each load condition.

3. Yaw - Load points designated with common letters equally and simultaneously in the same direction. Two points shown at one station on the planform drawing designate upper and lower truss or spar at that station. Load points with different letters separately, taking all deflection data for each load condition.

Measure effect of non-linearity by applying loads at three magnitudes such as 15%, 30%, and 45% of limit loads.

Apply loads through three cycles for each loading condition.

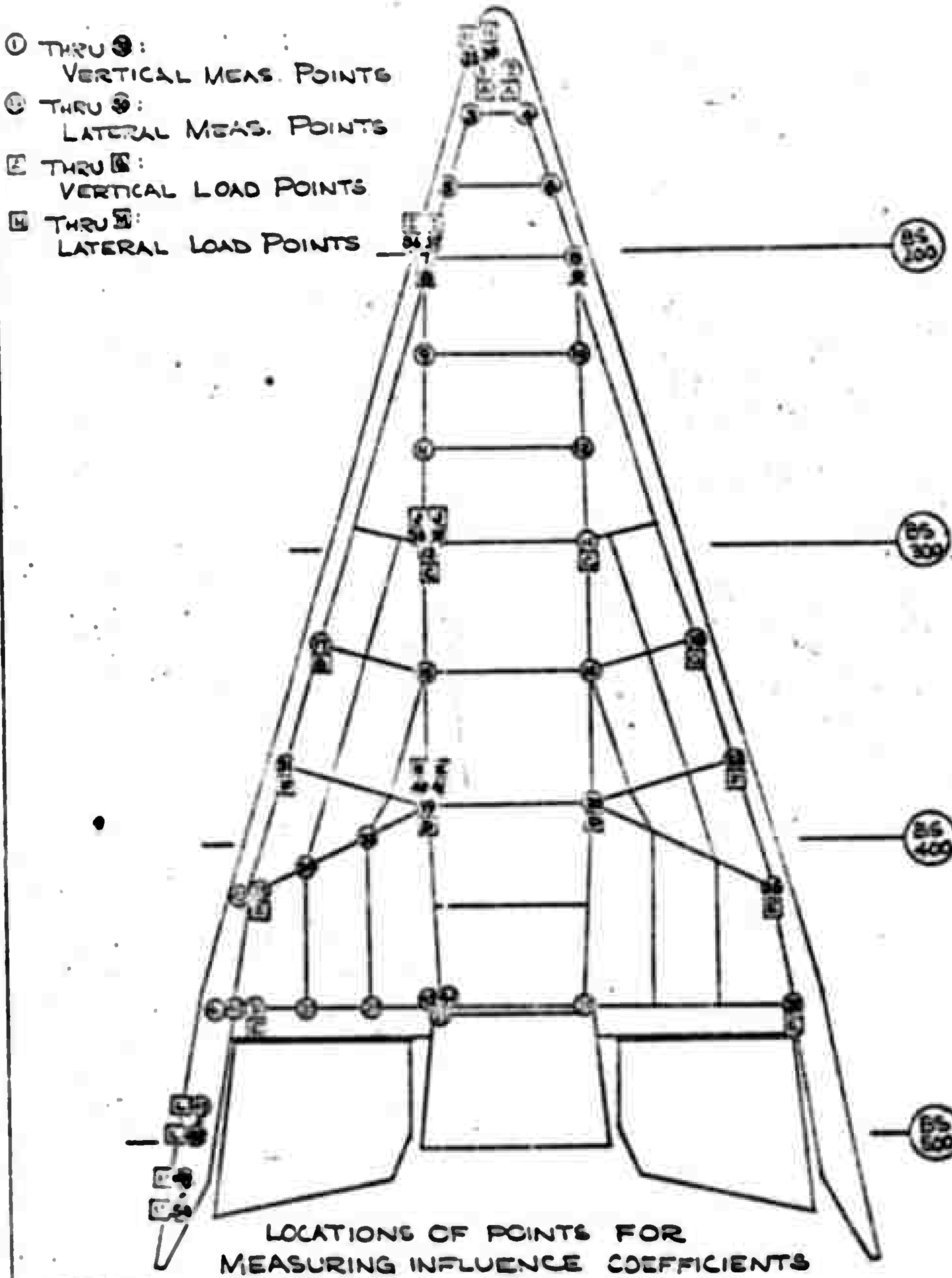
1.1.3.4 Data Requirements A data acquisition system capable of automatically printing out deflection data from 50 points shall be required.

1.1.3.5 Report Requirements To be inserted when available.

1.1.3.6 Facility and Equipment Requirements

Fifty (50) deflection measuring devices with range variable up to ± 5 inches.

Force measuring load cells with range variable up to 30,000 pounds. Quantity depends on test setup.



LOCATIONS OF POINTS FOR
MEASURING INFLUENCE COEFFICIENTS
— CONFIG. 2050

FIGURE 1.1.3-1

GROUP 4
DOWNGRADED AT 3 YEAR INTERVALS;
DECLASSIFIED AFTER
12 YEARS
DOD DIR 5200.10

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TITLE VERIFICATION TESTS - ACOUSTIC AND VIBRATION ENVIRONMENT, Section 1.1.4

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1.1.4 ACOUSTIC AND VIBRATION ENVIRONMENT VERIFICATION TEST REQUIREMENTS

These tests shall verify the Dyna-Soar acoustic and vibration environment and dynamic responses. These tests shall also demonstrate that the glider and transition structure are capable of withstanding the resulting forces and that representative structural components demonstrate adequate life under the oscillatory loads of sonic vibration tests. Test requirements will be inserted at a later date.

1.2 FLIGHT SIMULATION PROGRAM This section contains the test requirements for flight simulation programs as defined in section B(1.1.3.4) of reference (1). The flight simulation program is comprised of four separate parts: 1) Development Flight Simulator; 2) Dynamic Flight Simulation (Centrifuge); 3) Profile Mission Simulator; and 4) a Full Mission Simulator. As an expedient in presenting these requirements and to aid in document maintainability each part is presented under separate sub-section title page.

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TITLE DEVELOPMENT FLIGHT SIMULATOR

Section 1.2.1

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1.2.1 DEVELOPMENT FLIGHT SIMULATOR REQUIREMENTS
A development flight simulator shall be provided by Boeing for preliminary design verification, hardware development, and crew station evaluation.

1.2.1.1 Test Objective To establish and confirm vehicle and control system requirements in order to provide the desired handling qualities in all regions of flight.

1.2.1.2 Test Configuration The simulator shall consist of: a fixed base pilot's compartment with instrument displays, a 2 axis side stick controller, rudder pedals, and an analog computer representation of the vehicle and control systems.

1.2.1.3 Test Conditions The simulator shall be used to evaluate: (1) Control during re-entry where reaction control and aerodynamic control is used; (2) Handling characteristics throughout the flight corridor including hypersonic, supersonic and subsonic conditions; (3) Control during the abort phase; (4) Pilot controls and display requirements evaluation.

THE BOEING COMPANY

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TITLE DYNAMIC FLIGHT SIMULATION (CENTRIFUGE) TEST

Section 1.2.2

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1.2.2 DYNAMIC FLIGHT SIMULATION (CENTRIFUGE) TEST REQUIREMENTS The purpose of the crew station development program is to develop and verify the glider crew station and life support equipment design to provide engineering test of the glider subsystems and verify pilot performance under "g" forces. encountered during Dyna-Soar boost profile with hypothetical booster for a once-around mission.

1.2.2.1 Test Objectives

1. Crew Station Design. Develop and validate the crew station design under normal and emergency acceleration conditions. The validation will include the functional relationships of cockpit arrangement, display readability and control operability.

2. Subsystem Engineering Analysis. Investigate and verify air-vehicle controllability, abort-vehicle controllability and air-vehicle controllability with stability augmentation failures.

3. Pilot Performance. Develop fixed base man-machine system performance in the air vehicle. Pilot performance in back-up control modes, vehicle handling qualities, pilot workload, and pilot flight-management decisions will be evaluated. Pilot performance baselines will be obtained for comparison with flight test data.

4. Life Support and Biomedical. Develop and verify under normal and emergency acceleration conditions the adequacy of: (a) pilot ejection seat, in terms of support and restraint characteristics and body positioning; (b) pilot full pressure suit, in terms of pressurization functions, comfort and restriction of movement; (c) biomedical instrumentation in terms of adequacy in supplying medical monitoring data.

5. Pilot Support Activities, Physiological Preparation & Checkout. Develop and verify procedures and timing for pilot insertion, countdown, checkout, inflight voice reporting, post-flight debriefing and obtain pilot training baseline data.

1.2.2.2 Test Configuration Cockpit configuration used during these tests is based on that described in D2-8087, "Crew Station Design Requirements Specification" revised December 15, 1961. The simulator has been fabricated to be operable utilizing an unmodified two-gimballed Johnsville centrifuge and computer facilities. The cockpit configuration will be in accordance with the following:

1. Instrument panels per Boeing Drawing 25-80774, Pilot Instrument Panel Configuration dated January 31, 1962.
2. Equipment will be in accord with that shown on Boeing Drawing 25-80666, Equipment Installation - Cockpit, NADC Centrifuge Unmodified Two-Gimbal. This drawing installs such equipment as ejection seat, associated equipment, rudder pedals, side arm controller, abort handle, armrest and lamp installation.

1.2.2.2 Test Configuration (Cont'd)

3. Structure will be in accordance with Boeing Drawing 25-80598, Dyna-Soar Cockpit Installation - NADC Centrifuge Unmodified Two-Gimbal, Sheets 1 - 8.
4. Pressure suits to be supplied as GFAE similar to David Clark APS-22S-2.
5. Communications - Interrelated communication network between all test personnel.
6. Medical Equipment as designated by the Aero-Space Medical Research Laboratory (ASMD).
7. Photographic Equipment - Two T.V. Cameras, two 16 mm movie cameras -- one each trained on panel and pilot; and one camera for still picture of panel at burnout.

1.2.2.3 Test Conditions. Test conditions will be in accord with those outlined in D2-80415, Volume II, Crew Station Development Phase I(b) Simulation Program Technical Data. This document includes data instrumentation requirements, data collection program, simulated mission conditions, run schedules and associated performance characteristics of centrifuge.

1.2.2.4 Data Requirements. Data requirements are outlined in D2-80415, Volume II.

1.2.2.5 Report Requirements. The Dyna-Soar System Program Office - ASD is responsible for management, scheduling and direction of this program. In keeping with this responsibility all reporting will be accomplished by this agency. Boeing will provide technical assistance for preparation, maintenance of equipment, analog programming and assistance during test program.

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TITLE PROFILE MISSION SIMULATOR

Section 1.2.3

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Revised: [illegible]

1.2.3 PROFILE MISSION SIMULATOR REQUIREMENTS

An air launch profile mission simulator shall be established at AFFTC for pilot training and air launch mission planning. The simulator shall consist of a fixed-base pilots compartment with instrument displays and controls. Electrical conversation equipment in conjunction with a GFE computer shall present simulated air launch mission profiles for pilot training.

At the conclusion of the Dynamic Flight Simulation (Centrifuge) test the crew station equipment shall be installed and used as fixed-base flight simulator at AFFTC. Boeing shall update portions of the hardware as required, in particular the instrumentation, for delivery to AFFTC and shall maintain and support this equipment as required by AFFTC. Details of the equipment and support to be furnished by Boeing are to be presented in a detail specification.

Detailed requirements will be inserted at a later revision.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE FULL MISSION SIMULATOR

Section 1.2.4

The following section is being maintained by the Design Integration Test Requirements Group of the Systems Engineering Section.

PREPARED BY ____________ ______

SUPERVISED BY ____________ ______

APPROVED BY ____________ ______

RELIABILITY APPROVAL ____________ ______

DEVELOPMENT TEST REQUIREMENTS UNIT (DATE)

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2-5142
SECTION TITLE PAGE U3 4288 0000 REV. 1/61

1.2.4 FULL MISSION SIMULATOR REQUIREMENTS

A ground launch full mission profile simulator shall be established at AFMTC for range, ground, and flight crew integration training, mission planning, and pilot functions analysis. The simulator shall consist of a fixed-base pilots compartment with instrument displays and pilot controls. Electrical conversion equipment in conjunction with a GFE computer shall present simulated ground launch mission profiles for pilot training and mission planning.

Boeing shall provide equipment for the ground launch mission profile simulator at AFMTC. A detailed design specification shall be prepared by Boeing for SPO approval prior to fabrication.

Detailed requirements will be inserted at a later date. Planning requirements are contained in D2-80597.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. DS-1

TITLE ENVIRONMENTAL TEST MODEL

Section 1.3

The following section is being maintained by the Cryogenic Systems Integration Test Group.

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CHARGE NUMBER

SECTION TITLE PAGE U3 4288 3000 REV. 1/61

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Revised: 5-11-62

1.3 ENVIRONMENTAL TEST MODEL - Environmental test models will be constructed and tested for the purpose of verifying secondary power, environmental control, cryogenic supply and water wall performance. Thermal and operational tests will be conducted in accordance with the methods and procedures described in the Environmental Test Model Test Plan, D2-80364. The model will consist of two parts. The one part will be a simulated secondary power bay including all of the major functional components that make up the integrated hydrogen cooling and secondary power equipments. Interfacing equipment and supporting structure will be simulated. The second part will be a full scale pilot compartment including prototype or thermally simulated structure surrounding the compartment. Compartment atmosphere and temperature control equipment will be included. Internal compartment heat loads and other interfaces will be simulated. The test program will be conducted in the environmental simulator chamber at Tulalip. The test results will be documented.

1.3.1 SECONDARY POWER BAY TEST - Test to checkout operation of the environmental control, secondary power and cryogenic supply subsystem are required in accordance with reference (1). These operational verification tests are dependent on and shall be coordinated with preceding environmental control, secondary power, and cryogenic supply subsystem tests described in Volume II of reference (3).

1.3.1.1 Test Objectives To demonstrate and verify satisfactory operation and integration of the equipment in the secondary power bay (environmental control, secondary power, and cryogenic supply subsystem) under thermal and pressure conditions simulating orbital and re-entry flight environments.

1.3.1.2 Test Configuration A production secondary power bay will be used to conduct this test. It will be complete with water walls and insulation. The secondary power bay will be supported in the altitude chamber by simulated glider "hot" structure. No skin will be provided.

1.3.1.2.1 Major portions of the cryogenic supply and environmental control subsystems, and part of the secondary power subsystem will be installed in the secondary power bay. The following production items will be included: a hydrogen tank and controls, two oxygen tanks and controls, two H_2O_2 tanks and controls, two AP&CU's (with cold plates), a glycol-water temperature and hydrogen pressure control, two hydraulic fluid coolers, hydraulic reservoirs and accumulators, inflight nitrogen purge equipment, valves (fill, vent, shutoff and relief), umbilical connections and water wall panels.

1.3.1.2.2 Equipment which is part of the above subsystems but not located in the secondary power bay will be simulated. Water may be used in place of H_2O_2. The fire and safety system will be operated from a boiler-plate nitrogen tank. Production penetrations will be installed through the water wall (wiring, tubing, etc.).

1.3.1.2.3 The test will be conducted in the large, high-altitude test chamber in Area 34, Tulalip Test Site with the addition of suitable heat lamps, the test setup will be able to create calculated conditions of altitude and temperature. Mechanical AGE equipment will be used* for servicing of the oxygen, hydrogen and glycol system. A dolly will be designed to support the setup (including heaters) as well as move it between the assembly area and chamber.

*If available and operable.

1.3.1.3 Test Conditions Testing will be in two phases. Phase I will be ground service verification and sea level operation. Phase II will demonstrate satisfactory performance of the integrated secondary power, environmental control, and cryogenic supply, and fire and safety subsystems during a ground launch mission.

A. Phase I, Ground Service Verification and Sea Level Performance

The oxygen, hydrogen, and glycol systems will be serviced using Mechanical AGE equipment. The time required to fill the system will be established. Glider instrumentation will be evaluated in determining tank quantities and qualities. The integrated system will then be operated at sea level to demonstrate satisfactory pre-launch operation.

B. Phase II, Ground Launch Verification Tests

Phase II testing will be an extension of the sea level tests in Phase I. Heat lamps will provide a calculated and programmed temperature distribution on the support structure and the insulation. The steam ejectors in conjunction with the heat lamps will provide simulated orbit and re-entry profiles.

1.3.1.4 Data Requirements Data requirements will be inserted as they become available.

1.3.1.5 Report Requirements Report requirements will be inserted when available.

1.3.2 PILOT'S COMPARTMENT ENVIRONMENTAL TESTS The purpose of this test is to observe the performance of the active and passive pilot's compartment environmental protection equipment in simulated Dyna-Soar orbital and re-entry pressure and temperature environments. The results of this test will verify the ability of the subsystems to provide a habitable compartment environment in the severest heating and pressure conditions anticipated.

1.3.2.1 Test Objectives The specific objectives of this test are summarized as follows:

1.3.2.1.1 Water Wall Demonstration

1. Determine the effect of the geometry of the exhaust steam flow path (through the annular space between the pilot's compartment wall and the glider outer skin) on the water wall installation boil-off rates.

2. Assure that adequate water wall protection has been provided for all pilot compartment heat shorts.

3. Provide a basis for estimating the steam rates that result from similiar structural geometry in other glider locations.

4. Demonstrate that adequate quantities of water and sufficient structural durability have been provided in the individual water wall panels, and consequently, verify the ability of the complete water wall installation to provide adequate and reliable cooling.

1.3.2.1.2 Temperature Profile Studies

1. Obtain the temperature profiles of the compartment walls, compartment supports, and of equipment located within the compartment that result from simulated aerodynamic heating and compartment internal heat loads.

2. Insure that all heat shorts and areas of high heat transfer have been accounted for in the design of the water wall installation.

3. Compare the temperature profiles that result from the tests to the estimated compartment wall and equipment temperatures that were employed as design criteria.

1.3.2.1.3 Compartment Leakage Test Verify the integrity of the compartment walls, seals, hatches, external connections and interconnects in a range of temperature and pressure differentials across the compartment walls by determining quantitative compartment leakage.

1.3.2.1.4 Environmental Control Equipment Performance Tests

1. Demonstrate satisfactory operation of the compartment cooler, desiccant dehydrator, air ducting, and environmental control oxygen and nitrogen equipment located within the compartment.

2. Verify that the heat source supplied by the pilot's compartment to the glycol cooling loop is within design requirement limits.

1.3.2.1.4 (Continued)

3. Demonstrate that the pilot's compartment active environmental controls system will provide the temperature, pressure, and atmosphere, necessary to sustain life and provide cooling for avionic equipment, instruments, and controls in a range of simulated aerodynamic heating and internal heat loads.

4. Demonstrate the flexibility in the design of the equipment by obtaining the objectives of (2) above with the equipment in the emergency mode of operation, and by simulating equipment failure.

5. Establish the extent to which the heat sink provided by the compartment equipment can be utilized to provide emergency cooling, and verify that the established emergency procedures make the best use of that heat sink and provide the longest emergency period.

1.3.2.2 Test Configuration A production pilot's compartment with a complete water wall installation, all external plumbing and wiring interconnects, and the window installation and internal equipment as defined below will be mounted in the forward portion of a production Dyna-Soar glider. This assembly will be placed in a large vacuum chamber with its aft end, (See Figure I), facing the chamber pump suction inlet, and it will be heated with radiant heat lamps. The test model is further defined as follows:

1.3.2.2.1 Test Model Structure The test model structure will provide the heat inputs to the compartment and water wall installation that occur as a result of the elevated outer skin temperatures. For this reason it shall be composed of parts identical in geometry and thermal capacitance to a production glider fuselage and wings from glider station 178 to glider station 300, (See Figure II).

1.3.2.2.2 Test Model Subsystems Those glider subsystem components such as the forward landing gear, which significantly effect the thermal response of the test model shall be simulated.

1.3.2.2.3 Water Wall Installation Complete sets of production water wall panels for the pilot's compartment and the windshield cover heat shield shall be provided for this test.

1.3.2.2.4 Pilot's Compartment Structure and Equipment A production pilot's compartment with all windows, hatches and seals integral to the compartment wall will contain the equipment to be tested. The equipment is composed of those portions of the environmental control subsystems that control and effect the compartment environment. The equipment is summarized as follows:

1.3.2.2.4.1 Production Equipment

1. Compartment Pressure Control Components

2. Pilot's Compartment Environmental control package (cooler unit, heaters, N_2 & O_2 Equipment Components) and Controls

1.3.2.2.4.1 (Continued)

3. Dessicant Dehydrator

4. All ducting, diaphragms, plenums and bulkheads which control air flow and distribution within the compartment.

1.3.2.2.4.2 Simulated Equipment

1. Major electrical and avionic heat leads such as the TR unit, blocking diode, forward power box and flight controller.

2. Pilot's Suit - An operating simulator with flight configuration pressure and flow controls.

3. Panels and containers which influence air flow such as the pilot's seat or instrument panel (as opposed to those which control air flow as part of the environmental control system, paragraph 1.3.2.2.3.1).

4. Instruments - A resistance simulation of instrument heat loads.

1.3.2.2.5 Special Test Equipment Three categories of equipment will be needed for this test. They are:

1. That equipment necessary to supply coolant, gases or electrical power to the pilot's compartment equipment (See paragraph 1.3.2.2.4).

2. The equipment and fixtures necessary to support and transport the test model.

3. The jigs and fixtures necessary to support heating lamps.

1.3.2.3 Test Method The test model will be installed in the large environmental test chamber located at the Tulalip Test Site where its exterior surface will be exposed to the pressures and temperatures conditions typical of a Dyna-Soar re-entry profile. The operation and performance of the test model will than be observed as it reacts to the programmed aerodynamic heat load and internal heat loads which will be furnished by the operating systems. Three Dyna-Soar re-entry profiles will be simulated for these tests. Typical temperatures and pressures, correlated with time, that occur during these profiles are shown in Figures III & IV.

1.3.2.4 Instrumentation and data requirements can be broken into the broad categories of temperature, pressure, flow, chemical composition and weight. All shall be correlated with time.

1.3.2.4.1 Temperature Measurements These measurements shall consist primarily of high temperature measurement, 0 to 1800°F, of the test model skin (these sensors will be used to control the closed loop electrical heating system), of structural temperatures (to locate heat shorts and verify heat transfer estimates), and of steam temperatures in the annular space between the compartment wall and test model outer skin. However, lower temperatures such as compartment atmosphere, glycol cooler differential, and various equipment temperatures will also be measured.

1.3.2.4.2 Pressure Measurement The pressure external to the test model will be the pressure to which the chamber is controlled. It is, therefore, a primary measurement in the range of 0.10 to 760 mm Hg. Other important measurements will be annular space steam pressure, compartment pressure, and those pressures necessary to control the pilot's O_2 and N_2 supplies.

1.3.2.4.3 Chemical Composition The chemical composition of the pilot compartment atmosphere will be obtained for at least one profile and the percent oxygen and water vapor will be obtained for all runs.

1.3.2.4.4 Flow Measurement Gas flow from the compartment pressure control system, flow through the compartment cooler fan (air) and heat exchanger (glycol water), and various flows in the air duct distribution system will be measured.

1.3.2.4.4 Weight Each water wall panel will be weighed at the beginning and end of each test run.

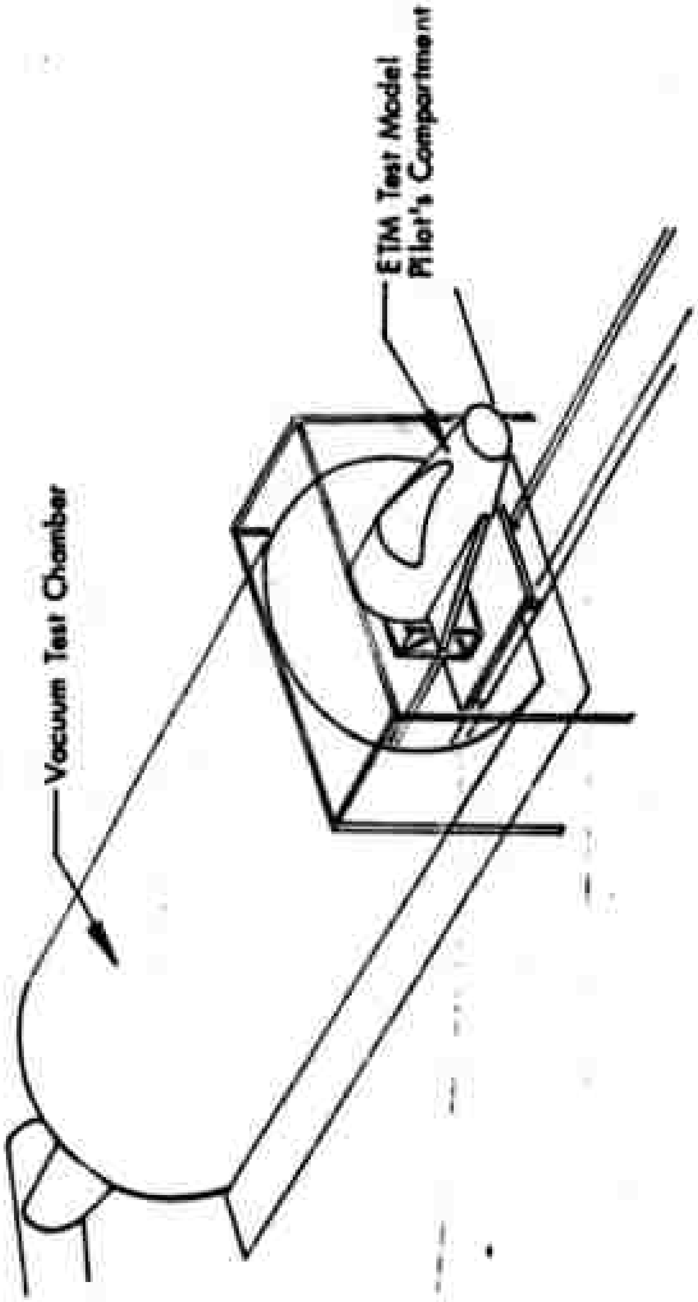
1.3.2.4.5 Report Requirements The following reports shall be prepared:

1.3.2.4.5.1 Preliminary Report A preliminary report shall be prepared immediately following each test run. This informal report shall contain the following information and it shall be written so as to supplement the detail test plan. The following information is the minimum requirement.

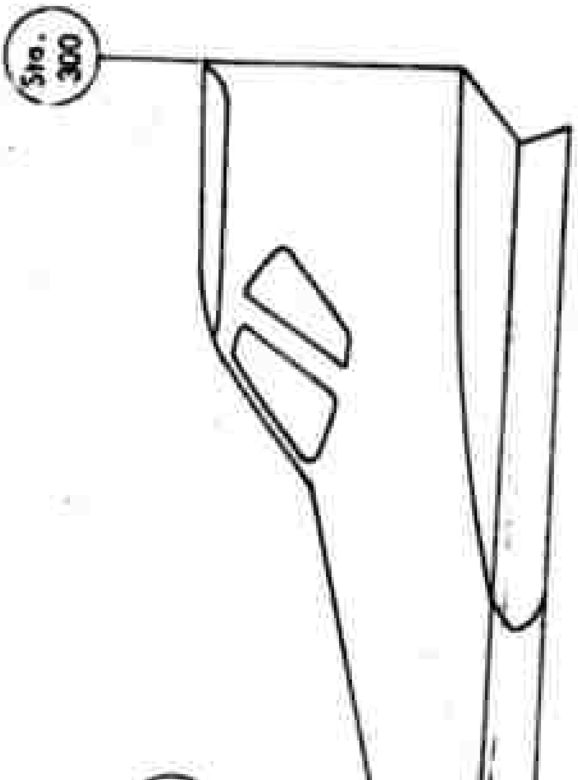
1. Test Configuration
2. Test Results and Preliminary Data
3. Test Discrepancies
4. Recommendations to Correct Test Discrepancies

1.3.2.4.5.2 Test Analysis Report This report shall be prepared as testing progresses. It shall contain the complete test results, and in addition, it shall contain as minimum requirements:

1. An explanation of the methods used to correlate pilot compartment water wall test results to verification of the entire water wall system.
2. An explanation of the testing methods and a statement regarding the accuracies of the test.
3. A comparison of test results with analytical heat transfer estimates, and recommended changes regarding future testing or analysis.
4. A complete list of test model equipment discrepancies with the corrective action taken.
5. A complete list of test equipment.
6. A complete data reference.

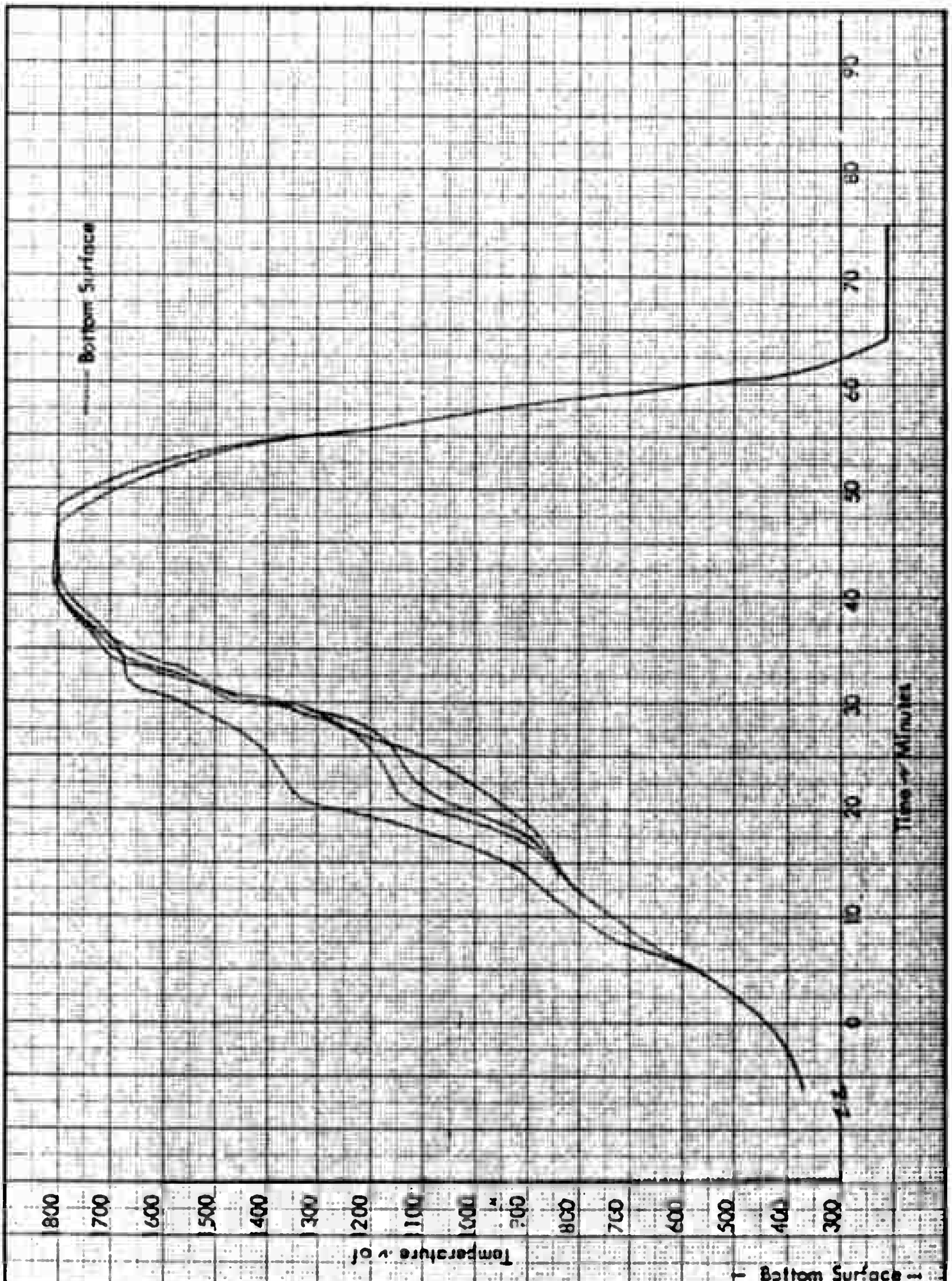


PILOTS COMPARTMENT TEST CONFIGURATION
Figure 1



PILOTS'S COMPARTMENT

Figure 2



CALC	Map	4-12	REVISED	DATE	Figure 3 Typical Time ~ Temperature Histories Pilots Compartment	D2-7924
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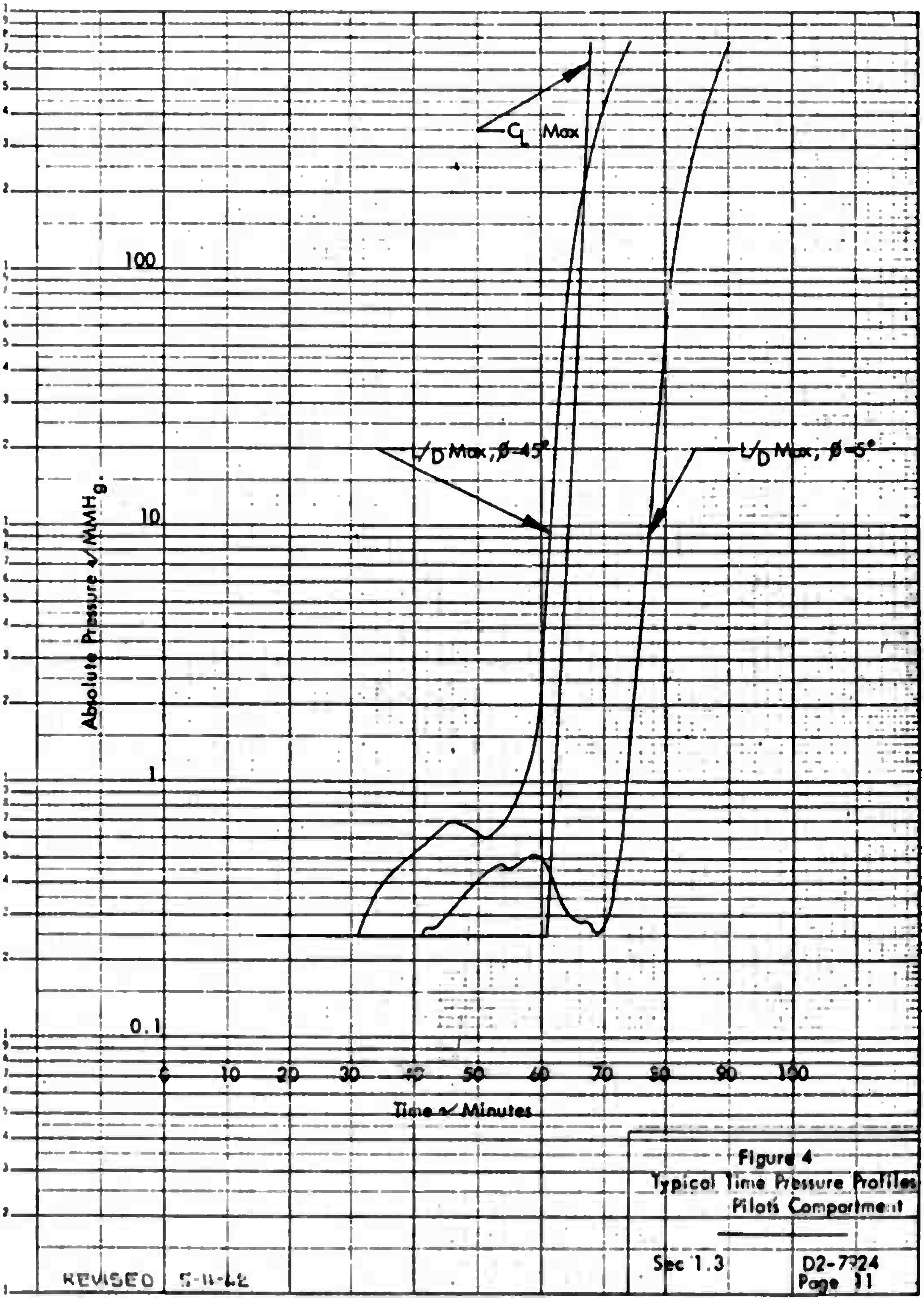

Figure 4
Typical Time Pressure Profiles
Pilots Compartment

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NUMBER D2-7924 MODEL NO. D.S. I

TITLE GUIDANCE AND CONTROL DEVELOPMENT MODEL

Section 1.4

The following section is being maintained by the Guidance and Control Simulator Group of the Electronics and Guidance Section.

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APPROVAL	W. F. Mickles DEVELOPMENT TEST REQUIREMENTS UNIT	9/17/62 (DATE)

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1.4 GUIDANCE AND CONTROL DEVELOPMENT MODEL TEST REQUIREMENTS The aim of the Guidance and Control Development Model is to provide a means for integrating the guidance and flight control subsystems in an effort to optimize overall control system performance and reliability. This will involve integration of those subsystems comprising the control loops including guidance equipment, cockpit instruments and controls, pilot, stability augmentation, actuation devices, and vehicle dynamics. The Guidance and Control Development Model will provide the only facility for operation of the vehicle control subsystems together prior to installation in the vehicle.

1.4.1 Test Objectives The general objective of these tests is to demonstrate that the various subsystems which make up the control loop (inertial guidance, flight control electronics, control equipments, displays, and pilot) operate compatibly one with another and as an integrated system that fulfills the design requirements.

1.4.2 Test Configuration The Guidance and Control Development Model (G&CDM) shall be composed of:

1. An analog computer which will be programmed to represent a six-degree-of freedom simulation of vehicle dynamics and also to provide standby analogs of the various equipments (The computer capacity shall be equivalent of two EASE computer consoles with a high proportion of non-linear equipment.) The analog computer shall be required on a full time basis to support the G&CDM.

2. A cockpit mock-up which includes pilot seat and restraint system, controls, display instruments, and pilot.

3. Mock-ups of the control surfaces with prototype hydraulic actuation system including servo electronics.

4. Simulation of the booster controls.

5. Simulation of the reaction control system.

6. Actual prototypes of the guidance and flight control electronics.

7. Signal conditioning equipment as necessary to inter-connect glider hardware with the analog simulation.

8. Remote control, interlock circuitry, and system test equipment to operate and check out the G&CDM.

9. The necessary wiring, etc. to form a realistic mock-up of the vehicle.

10. Prototype hydraulic power supply and distribution system.

11. Laboratory instruments and equipment to support the tests.

1.4.3 Test Conditions Prototype models of the guidance and control electronics shall be integrated one with another and with the vehicle control elements as simulated in the Guidance and Control Development Model. A sufficient number of flight conditions and modes shall be simulated to establish compatible operation of the subsystems. Specific conditions of test follow:

1.4.3 (Continued)

1. The operational compatibility of the Inertial Guidance System (IGS) with the cockpit displays shall be verified by demonstrating that excitation of the IGS results in proper indications at the displays.

2. The compatibility of the hydraulic power supply with the Manual Flight Systems shall be demonstrated in conjunction with Manual Flight Control Testing.

3. Electrical and functional circuit compatibility of the Flight Control Subsystem Electronics (FCSE) with the cockpit displays, sidestick controller, rudder pedals, reaction controls and surface controls shall be demonstrated. Response of the systems to proper input signals shall be evaluated.

4. Compatibility of operation and performance between the Primary Guidance System, displays, and FCSE shall be demonstrated. Response of the control elements to typical guidance system excitations shall be evaluated.

5. Integration and evaluation of the complete guidance and control system shall be performed at various flight conditions which are typical of all conditions to be encountered in actual test flights. The choice of exact conditions to be simulated will depend on the final definition of flight trajectories. Tests shall be run to accomplish the following:

   a. Verify that no electrical or mechanical couplings or interactions exist between control and guidance subsystems that will degrade system performance to an unacceptable level.

   b. To measure vehicle response characteristics and demonstrate that the prototype hardware performs in accordance with specifications in maneuvering the vehicle and adhering to the trajectory.

   c. To evaluate vehicle dynamic behavior and verify that performance conforms with specifications for stability margins, maximum rates, accelerations, etc.

   d. To evaluate the transients which occur at the time of switching between primary and back-up guidance and when switching between automatic, augmented, or manual-direct control. All switching combinations possible in the final guidance and control configuration shall be considered. Effects to be examined are control instabilities, structural loading, trajectory deviations, etc.

6. The combined reaction of the pilot and subsystems to guidance and flight control equipment malfunctions and the resultant effect on control stability and deviations to flight trajectory shall be evaluated for both manual and automatic control modes. The effectiveness of emergency control procedures in minimizing the effects of equipment malfunctions shall be evaluated.

7. Special characteristics of the guidance and control system that may affect system performance shall be studied. Characteristics to be studied are:

1.4.3 (Continued)

7. a. Small-signal characteristics of the flight control system, including dead-band and hysteresis effects.

   b. Non-linearities in the guidance and control system, such as gain and saturation characteristics of the servo valves and actuators, dynamic range of amplifiers, etc.

8. Some testing may be required to support mission planning such as determining means of programming desired maneuvers, and verification (using the actual hardware) of vehicle response characteristics to such programs.

1.4.4 <u>Data Requirements</u> To be determined and inserted when available.

1.4.5 <u>Report Requirements</u> To be determined and inserted when available.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. DS 1

TITLE ESCAPE AND SURVIVAL SYSTEM AND HEAT SHIELD JETTISON SYSTEM TESTS (SLED)

The following section is being maintained by the Crew Accommodations and Escape System Group of the Glider and Transition Design Section.

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DEVELOPMENT TEST REQUIREMENTS UNIT (DATE)

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SECTION TITLE PAGE D2-5102

1.5 ESCAPE AND SURVIVAL SYSTEM AND HEAT SHIELD JETTISON SYSTEM TEST REQUIREMENTS (SLED TESTS) The escape system concept requires demonstration of the functional compatibility between the subsonic ejection seat system, glider escape hatch, and personnel protection system.

The performance of the Heat Shield Jettison System, while functionally independent of the escape system, will be demonstrated during the same test sequence. This is done to take advantage of the sled fixture and track facilities availability.

1.5.1 Test Objectives. (1) To verify satisfactory performance of the subsonic ejection sequence including; jettisoning the glider escape hatch, ejecting the seat, separating an instrumented test figure and survival kit from the seat, and deploying the recovery chute.

(2) To verify satisfactory performance of the window heat shield jettison system under typical dynamic loads.

Prior to conducting ejection system sled runs a demonstration of static firing of the escape hatch jettison system will be required.

1.5.2 Test Configurations. The sled tests will utilize government track test facilities (Edwards Air Force Base) and a suitable test sled, fabricated by Boeing to be adaptable to track slippers and propulsion pusher sled supplied by the test facility. The test mechanism will be comprised of the ejection seat and survival system and a pressure suited anthropomorphic dummy installed within an enclosure simulating dimensionally and aerodynamically the cockpit and upper surface of the Dyna-Soar glider from the nose to the back of the pilot compartment. This structure is to include the glider escape hatch and release mechanism. The window heat shield and jettisoning system will be installed on the sled for the heat shield runs.

The same glider sled structure will be used for static firing of the escape hatch jettison system. The latter testing will be conducted in the Seattle area.

1.5.3 Test Conditions

Condition I: Three static firings of the escape hatch will be conducted in the Seattle area to demonstrate proper initiation and separation characteristics. The hatch will be tethered or otherwise recovered to minimize chance of hatch or sled damage.

Condition II: Three ejection system sled test runs, with ejection seat and escape hatch, shall be programmed for air velocities of 70, 400, and 510 knots respectively. Demonstration of successful ejection will be required at each of these velocities. A fourth ejection system run will be programmed in initial planning for use as required for re-run or for demonstration of ejection capability under acceleration conditions.

Condition III: Three windshield heat shield sled test runs will be conducted at velocities to be determined. If practical, these will be combined with ejection system runs, however, initial planning will consider the need for three additional sled runs for this purpose.

1.5.4 Data Requirements.

Condition I: Time referenced high speed photographic coverage of hatch trajectory.
Hatch thruster and fastener initiator circuit current and thruster stroke.

Condition II: Time referenced photographic coverage to record trajectory of the escape hatch and ejected mass, parachute deployment, pilot figure deflections during catapult firing and clearance of the ejected mass as it passes through the hatch opening.

The anthropomorphic dummy shall be instrumented to record acceleration forces during ejection.

The escape hatch jettison system shall be instrumented to record thruster and fastener ignition circuit current and thruster stroke vs time.

Condition III: Time referenced photographic coverage to record window heat shield operation and trajectory.

The window heat shield jettison system shall be instrumented to record actuator stroke and pressure vs time.

1.5.5 Report Requirements.

Condition I: A test report consisting of detail test activities, test results and reduced data will be prepared and submitted by the Boeing testing activity within one month of completion of tests.

Conditions II and III: Interim test reports will be prepared by the testing contractor (Weber Aircraft Corporation) after each sled run outlining test condition, test results, failure analyses of the ejection system and recommended action preparatory to the next runs. These reports will forward preliminary reduced data for all systems tested.

A final test report will be prepared and submitted to Boeing by the testing contractor to demonstrate that performance requirements of the ejection system were met. This report will also contain data necessary for Boeing to report on qualification of the Boeing items, hatch and heat shield jettison system.

THE BOEING COMPANY

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TITLE ACCELERATION ROCKET STAGING TEST, Section 1.6

The following section is being maintained by the Transition Configuration Group of the Glider and Transition Design Section.

PREPARED BY

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APPROVED BY

APPROVAL W. F. Miller 4/30/62
DEVELOPMENT TEST (DATE)
REQUIREMENTS UNIT

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CONTRACT NO.

CHARGE NUMBER

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SECTION TITLE PAGE U3 4384 9000 REV. 7/61

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1.6 ACCELERATION ROCKET STAGING TEST REQUIREMENTS The Glider Separation/Escape System Concept requires demonstration that the acceleration rocket, its controls and mounting are satisfactory; and that the abort vehicle separation transient performs satisfactorily.

1.6.1 Test Objectives To demonstrate the separation sequence during a full scale transition section staging test. To include verification of the acceleration rocket start transients, blast port cover release and ejection, separation of the transition section at the abort separation plane, thrust vectoring controls, engine mounting provisions, transition structure, and the acceleration rocket hydraulic system.

1.6.2 Test Configuration The test configuration shall include production or prototype articles consisting of the glider acceleration rocket, all rocket controls and circuitry, transition structure (including blast doors and blast shield), hydraulic system including the actuators and servo valves; all devices, mechanisms, and circuitry used to control and sequence separation and thrust vectoring.

The test set-up shall be in a horizontal configuration with provisions for separation of the simulated booster section in a time/distance sequence to simulate actual glider/booster staging during initial breakaway.

1.6.3 Test Conditions The functionally integrated glider/booster transition section, acceleration rocket, thrust vectoring provisions, and the simulated booster section shall be tested as follows:

Prior to firing the acceleration rocket, a functional test of the acceleration rocket hydraulic system shall be conducted with typical flight control signals to the servo valves. The test shall consist of a simulated transition section staging sequence including acceleration rocket ignition, blast port cover release and transition separation. Flight control signals to the servo valves will be initiated to vector the rocket engine during rocket operation. The design adequacy of the transition separation and acceleration rocket control shall be demonstrated.

After each test the acceleration rocket thrust vector hydraulic system shall be inspected for damage and leakage followed by a functional test to determine any changes in performance.

1.6.4 Data Requirements Pressure, temperature, vibration, and acoustical measurements shall be made at various locations throughout the test vehicle during the rocket start transient, and steady state operation.

Data shall be obtained to verify proper rocket nozzle deflections consistent with thrust vector control signals. Post test examinations will determine the adequacy of rocket mounting structure, transition section structure, jet blast protective devices, and equipment mounted in the transition compartment.

Acceleration rocket hydraulic system data requirements are shown below:

1.6.4 (Continued)

DESCRIPTION OF MEASUREMENT	RANGE OF INFORMA-TION REQ'D	ACCURACY OF VARIABLE ± %	FREQUENCY OF VARIABLE CPS	REQUIRED SAMPLE RATE SPS
ACCELERATION ROCKET HYD SYSTEM				
1. Vibration at the Actuator Attachments	TO BE DETERMINED			
2. Accumulator Hydraulic Pressure	0-4500 psi	2.5	40	200
3. Hydraulic System Pressure	0-4500 psi	2.5	40	200
4. Hydraulic System Flow Rate	0-5 GPM	5	10	50
5. Reservoir Fluid Temp.	20-400°F	2.5		1
6. Pump Fluid Temp.	20-400°F	2.5		1
7. System Pressure Line Fluid Temp.	20-400°F	2.5		1
8. Hydraulic Actuator Case Temperature (4 Actuators)	10-900°F	2.5		1

1.6.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE GLIDER SUBSYSTEM INTEGRATION

Section 1.7

PREPARED BY

SUPERVISED BY

APPROVED BY

RELIABILITY APPROVAL

(DATE)

AF33(657)-7132
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CHARGE NUMBER

2-5142

SECTION TITLE PAGE U3 4288 0000 REV. 1/61

Revised:

1.7 GLIDER SUBSYSTEMS INTEGRATION TEST REQUIREMENTS This section contains requirements for those engineering tests to be performed on the first gliders proceeding thru the Systems Integration Laboratory (SIL). These are "one-of-a-kind" engineering tests, over and above the system level functional tests performed on each glider. To reiterate, these requirements are for engineering tests over and above the system level functional (repetitive) test requirements contained in book form drawings 21-81001 thru 21-81025.

This section contains requirements for those tests to be performed on the glider and of a scope such that separate subsection identity is not warranted.

1.7.1 Test Objectives To mate the glider with its OCOE and to verify the functional compatibility of installed glider subsystems with themselves, with the transition section, and with the OCOE. To analyze test procedures and refine requirements for future repetitive system level functional tests.

1.7.2 Test Configuration A complete glider, forward transition section, a set of ground operational equipment (OCOE), and miscellaneous ground servicing and handling equipment shall be required. The glider shall be fully assembled with all equipment installed and operational with the exception of explosive items which will be simulated with inert units. The complete glider along with all OCOE required for glider checkout will be assembled in the SIL testing facilities. Tests using cryogenic fuels will be conducted in the SIL isolated test facility.

1.7.3 Test Conditions Conditions of test are currently being revised and will be inserted at a future revision.

1.7.4 Data Requirements To be inserted at a future revision.

1.7.5 Report Requirements To be inserted at a future revision.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE GLIDER/B-52 COMPATIBILITY

Section 1.8

PREPARED BY

SUPERVISED BY

APPROVED BY

RELIABILITY APPROVAL

DEVELOPMENT TEST REQUIREMENTS UNIT (DATE)

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1.8 GLIDER/B-52 COMPATIBILITY TEST REQUIREMENTS The requirement of this test is to physically connect an air launch glider, including a forward transition section, to a pylon under the right wing of a B-52 carrier aircraft and to check functional compatibility of all subsystems connected between the glider and B-52 by means of a pylon umbilical.

1.8.1 Test Objectives The objectives of this test are:

1. To demonstrate satisfactory physical connection of the glider, including a forward transition section, to the B-52 aircraft.

2. To verify functional compatibility of all subsystems interacting between the glider and B-52, and the identification and solution of electro-interference problems.

3. To demonstrate the capability of the glider to withstand the acoustic and vibration environment created when the B-52 engines are operated at military power.

4. To demonstrate integrity of the APU exhaust system with the B-52.

5. To verify the functional compatibility of the B-52 glider monitoring subsystems.

1.8.2 Test Configuration A complete air launch quality glider and forward transition section with an inert mass simulated acceleration rocket motor shall be suspended from the B-52 carrier aircraft by means of a pylon located under the right wing between the fuselage and #5 engine.

The B-52 shall be equipped with interfacing subsystems required for glider function indication, emergency control signals, power transfer and glider/B-52/ground communications. Observation equipment and recording cameras shall be installed in the B-52.

The following is a list of AGE required for the glider/B-52 compatibility test program.

OCOE

1. Communications and Tracking C/O Set
2. Control Station
3. Electrical Power Supply
4. Hydraulic Power Supply
5. Junction Cabinets and Interconnectors
6. Squib Monitor and Simulator
7. Antenna Couplers and Wave Guides
8. Leakage Detector Set

GHE

1. B-52 Tow Bar
2. Vehicle, Towing
3. Transition Section Truck

1.8.2 (Continued)

GHE (Continued)

4. Glider Truck
5. Glider Protective Cover
6. Transition Protective Cover

GSE

1. Mobile Ground Power (Electrical) for B-52
2. Air Conditioner - Trailer Mounted
3. Glider Maintenance Stand
4. Work Stands
5. Misc. Lab Test Equip. (VTVM's, Oscilloscopes, Standard Lab Equipment)
6. Portable B-52 Air Power Cart

Special Equipment

1. Sound detection and recording equipment

1.8.3 Test Conditions Prior to the conduct of glider/B-52 compatibility testing the B-52 shall undergo a preliminary checkout of its special console and power transfer subsystem. A ground electrical power source will be required for this checkout.

The compatibility test program consists of:

1. Functional checkout of the following glider/B-52 interface systems

   Glider electrical voltage
   Interphone system
   Control systems
   B-52 electrical generation control equipment
   B-52 release function controls and indicators
   Power transfer from B-52 to glider

2. Check of physical compatibility of Glider/B-52

   Raise glider into position with dolly.

   With glider still in position on dolly and physically mater to B-52 operate release mechanism from release station.

3. Verify glider aerodynamic control surface clearance with B-52 and ground.

4. Check of pilot accessibility.

5. Conduct electro-interference tests. (See Section 1.14)

1.8.3 (Continued)

6. Conduct B-52 engine run-up tests to demonstrate the glider and glider subsystems capabilility to withstand the acoustic and vibration environment. A functional test of glider subsystems, following the engine run-up, will determine any performance degradation.

7. Conduct an APU exhaust integrity test. The glider APU's will be operated to verify APU exhaust integrity with the B-52 wing and pylon stack.

1.8.4 Data Requirements

Voltage and resistance measurements of release mechanism circuits
Main A.C. bus voltage (each phase)
Main A.C. bus frequency
Current into main A.C. bus (each phase)
Control signals
Acoustic and vibration measurements
Electro-Interference readings

1.8.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE GLIDER DESTRUCTOR SET TEST

Section 1.9

The following Section is being maintained by the Propulsion and Ordnance Group of the Glider and Transition Design Section.

PREPARED BY

SUPERVISED BY

APPROVED BY [illegible] 4/24/62

APPROVAL W. J. Minkle 4/24/62

DEVELOPMENT TEST REQUIREMENTS UNIT (DATE)

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1.9 GLIDER DESTRUCTOR SET TEST REQUIREMENTS A test to demonstrate the adequacy of the destructor set to completely sever the target structural members upon initiation and thus destroy the glider's capability for stable flight, is required by the Atlantic Missile Range (AMR). The requirement is contained in AFMTC Regulation 80-7: Airborne Flight Termination Systems (Range Safety), dated 26 April 1960. The approval and release of the Dyna-Soar glider for flight (unmanned ground launch) by the Range Safety Officer at AMR is contingent upon the successful results of this test.

1.9.1 Test Objective The objective of this test is to demonstrate the capability of the destructor set to completely sever the following listed wing structural members at the locations shown. Complete severance of the members by the destructor set shall comprise satisfactory performance.

Aft Torque Box Member	Between
1. Upper Chord - Rear Spar	L.B.L 25.0 and 37.4
2. Lower Chord - Rear Spar	L.B.L 25.0 and 33.0
3. Diagonal Member - Rear Spar	L.B.L 25.0 and 33.0
4. Upper Chort - Front Spar	L.B.L 28.5 and 36.75
5. Lower Chort - Front Spar	L.B.L 28.5 and 36.75
6. Diagonal Member - FrontSpar	L.B.L 28.5 and 36.75

1.9.2 Test Configuration A fully qualified destructor set shall be utilized as well as portions of the L.H. glider wing and fuselage. The explosive charges, safe/arm device and linear explosives shall be mounted in their normal flight positions. All primary and secondary structure, waterwall, insulation, tubing, etc., which may impede the explosive jets or reduce their effectiveness shall be installed and shall be of the same configuration and material as the flight hardware. Other test equipment and apparatus required shall include:

Remote test site
Remotely operated high speed cameras
Block house or other protective barrier
Associated wiring and instrumentation

1.9.3 Test Conditions The test article shall be supported so that the support structure will not interfere with or confine the cutting affect of the destruct charges. The test article shall be destructed in a remote location with the signal initiated from the blockhouse or other protective barrier. No special heating, cooling or pressure devices shall be used. High speed cameras shall record the test.

1.9.4 Data Requirements Visual observation of the test, visual inspection of both the tested part(s) and the slow motion film, by the Range Safety Officer, shall establish the adequacy of the destructors.

1.9.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE PILOT SUIT INTEGRATION TEST, Section 1.11

The following section is being maintained by the Crew Accommodations and Escape Systems Group of the Glider and Transition Design Section.

PREPARED BY [illegible] 4-18-62

SUPERVISED BY [illegible] 4/15/62

APPROVED BY

APPROVAL W. J. [illegible] 4/19/62
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1.11 PILOT SUIT INTEGRATION TEST REQUIREMENTS

The pilot's pressure suit is a government furnished item for the Dyna-Soar Program. However, the importance of the pilot's role in the mission and the integration with other glider subsystems requires that compatibility be demonstrated.

1.11.1 Test Objectives. To verify that the pilot environment in the Full Pressure Suit Body Restraint System is compatible with human requirements for the performance of his Dyna-Soar flight tasks. Tests will be conducted in two phases, the first early in the suit development program to confirm compatibility in the design approach. The second phase will be conducted utilizing a prototype Dyna-Soar suit.

Data from the following developmental and integration tests will be utilized in conjunction with this test program to verify the overall environmental compatibility:

Engineering Developmental Mockup (Crew Station and ejection seat spacial and fit considerations)

Side Arm Controller Development (Flight control capability)

Pilot Station Centrifuge Tests (Effects of acceleration forces)

Ejection System Sled Tests (Ejection capability)

1.11.2 Test Configurations.
Pilot subject dressed in a pressure suit.

Pressure chamber with simple crew station simulation capable of simulating normal and emergency crew station pressure and crew station ambient temperature.

Pilot atmosphere control simulating normal and emergency flow rates and temperature.

Heat radiation source to simulate hot window effects.

1.11.3 Test Conditions. With the pilot subject dressed in the pressure suit in the pressure chamber, observe pilot comfort and ability to perform simulated pilot tasks. Repeat with normal and emergency environment and with hot window simulation.

1.11.4 Data Requirements. Pilot temperature and perspiration rates under each condition. Pilot comments.

1.11.5 Report Requirements. A test report will be prepared by the testing organization for each phase of testing outlining test conditions, procedure and qualitative and quantitative results. These reports will be submitted to the design group within two weeks of the completion of each test phase.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE TEST INSTRUMENTATION SUBSYSTEM INTEGRATION TEST

Section 1.12

The following section is being maintained by the Systems Engineering Group of the Test Data Systems Unit, D.S. Test Engineering Section.

PREPARED BY [illegible] 4-[illegible]-62

SUPERVISED BY [illegible] 4/11/62

APPROVED BY [illegible] 4/16/62

APPROVAL [illegible] 4/25/62

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1.12 TEST INSTRUMENTATION SUBSYSTEM INTEGRATION TEST

The requirements of this test are the integration of the Test Instrumentation Subsystem. The test shall be used to verify the compatibility of the conversion equipment, signal conditioners, Test Instrumentation Checkout Set, and the electrical equivalent wiring harnesses and transducers, along with the airborne transmitter. This test will be performed in the Data System Laboratory with prototype conversion equipment.

1.12.1 Test Objectives The objectives of this test are:

1. Verify functional compatibility of all components of the subsystem including the Test Instrumentation Checkout Set.

2. Verify the system test procedures and equipment.

3. Determine the changes, if required, to the production equipment and test procedures to meet the data system accuracy requirements.

4. Determine the compatibility of the Test Instrumentation Subsystem with the Airborne Transmitter.

5. Provide the training of the operational personnel in the operation of the equipment.

1.12.2 Test Configuration The airborne portion of the Test Instrumentation Subsystem and the Airborne Transmitter will be set up on a bench in the Data System Laboratory. The glider interfaces will be electrically simulated to determine the glider effects. The following is a list of equipment required to support these tests:

1. Test console (includes power supplies, jacks, etc.)

2. Transducer simulation console

3. Test Instrumentation Checkout Set

4. System Integration Laboratory ground station

5. Communications and Tracking GCOE equipment as specified by the Communications and Tracking Design Group.

1.12.3 Test Conditions Integration of the Test Instrumentation Subsystem shall be comprised of four test phases: an airborne conversion and storage equipment test, an airborne Test Instrumentation Subsystem/TIS checkout set compatibility test, an airborne TIS reference test, and a TIS/airborne transmitter integration test.

1.11.3.1 Airborne Conversion and Storage Equipment Test - The accuracy of the airborne conversion and storage equipment shall be determined. A specific configuration of voltages shall be applied to the input of the conversion equipment. The Pulse Code Modulated (PCM) output shall be programmed and evaluated from computer processed data and the Frequency Modulated (FM) data shall be recorded on oscillographs for evaluation.

1.12.3.2 Airborne TIS and TIS Checkout Set Compatibility Test - The airborne Test Instrumentation Subsystem shall be mated with the TIS checkout set. A sufficient number of simulated conditions and modes will be evaluated to verify compatible operation.

1.12.3.3 Airborne Test Instrumentation Subsystem Reference Tests - Airborne Test Instrumentation Subsystem reference tests shall be conducted to establish an end-to-end subsystem accuracy evaluation of the entire airborne subsystem. The subsystem shall be tested in the configuration of the first ground launch vehicle and shall establish a reference for future evaluation with tests performed in the Systems Integration Laboratory and at the AFFTC and the AFMTC.

1.12.3.4 Test Instrumentation Subsystem/Communication-Tracking Subsystem Integration Test - Prototype models of the airborne communication and tracking equipment shall be integrated with the Test Instrumentation Subsystem. The test shall check the sub-carrier output voltage from zero input voltage through bandedge and shall verify the compatibility of the composite PCM and FM signal with the input requirements of the airborne transmitter.

1.12.4 Data Requirements

1) Computer processed PCM data
2) Oscillograph records of FM data
3) Operational time

1.12.5 Report Requirements Report requirements will be included when available.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE COMMUNICATIONS & TRACKING SUBSYSTEM INTEGRATION

Section 1.13

The following section is being maintained by the Communications Equipment Group of the Electronics and Guidance Section.

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APPROVED BY

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1.13 COMMUNICATIONS & TRACKING SUBSYSTEM (CTS) INTEGRATION TEST REQUIREMENTS

These tests shall verify the compatibility of the airborne communication and tracking equipment one with another, with the Boeing developed antenna and feedlines, with the CTS GCOE prototype, and with the Test Instrumentation Subsystem (See Section 1.12). Test requirements will be inserted at a later date.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D. S. I

TITLE GLIDER ELECTRO-INTERFERENCE COMPATIBILITY

Section 1.14

The following section is being maintained by the Electro-Interference Group of the Communications and Transducers Unit.

PREPARED BY [illegible] 4/12/62

SUPERVISED BY [illegible] 4/16/62

APPROVED BY [illegible] 4/16/62

APPROVAL [illegible] 4/19/62
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1.14 GLIDER ELECTRO-INTERFERENCE (E-I) COMPATIBILITY TEST REQUIREMENTS

This section contains the technical requirements for electro-interference (E-I) testing to be conducted on the first two flight configuration gliders in the Systems Integration Laboratory. These are engineering tests and will be conducted in conjunction with the Glider Subsystem Integration tests (See section 1.7).

1.14.1 Test Objective To determine that no detrimental electrical or electronic interference occurs during glider subsystems operation.

1.14.2 Test Configuration A complete glider, forward transition section, a set of ground checkout operational equipment (GCOE), and miscellaneous laboratory equipment shall be required. The glider shall be fully assembled with all equipment installed and operational with the exception of explosive items which will be simulated with inert units. Power, air, external signals, etc., shall be supplied as required to operate the glider subsystems. All covers and panels shall be in place. The complete glider along with all GCOE required for glider checkout will be assembled in the SIL.

1.14.3 Test Conditions Glider systems in conjunction with the GCOE shall be operated to simulate a countdown, launch and various possible sequences and combinations anticipated for in flight operations to determine that no detrimental electrical or electronic interference occurs. MIL-E-6051 C (ref. 3) shall be used as a guide in performing these tests. All electrical and electronic equipment in the glider will have previously been subjected to tests and satisfactorily met the requirements of MIL-I-26600 (ref. 4).

Ambient interference levels in the test area should not be more than 4 db above the internal noise level of the most sensitive equipment involved.

1.14.4 Data Requirements To be determined by the Electro-Interference Group of the Communications and Transducers Unit.

1.14.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE REMOTE CONTROL RECOVERY SUBSYSTEM INTEGRATION

Section 1.15

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SUPERVISED BY

APPROVED BY

RELIABILITY APPROVAL DEVELOPMENT TEST REQUIREMENTS UNIT (DATE)

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1.15 REMOTE CONTROL RECOVERY SUBSYSTEM INTEGRATION TEST REQUIREMENTS

The Remote Control Recovery Subsystem (RCRS) will be supplied as GFAE and will consist of the Sperry Microwave Command Guidance (MCG) System. The RCRS provides for the landing and recovery of unmanned gliders during the unmanned ground launch program. The following Section will contain the technical requirements for those engineering tests required to verify compatibility of the RCRS with the glider flight control subsystem and recovery flight operations. This will include all "one-of-a-kind" engineering tests in the Systems Integration Laboratory (SIL), AFMTC, AFFTC, and the QF-104 tests.

II. AIR VEHICLE - GENERAL

The following sections encompass the requirements for those tests directly concerned with the physical and functional mating of the glider to the booster prior to the ground launch program; and the requirements for support of the air vehicle dynamic test.

THE BOEING COMPANY

NUMBER D2-7924 MODEL NO. D.S. I

TITLE GLIDER/BOOSTER COMPATIBILITY

Section 2.1

PREPARED BY

SUPERVISED BY

APPROVED BY

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2.1 GLIDER/BOOSTER COMPATIBILITY TEST REQUIREMENTS The requirement of this test is to align and physically connect for the first time the glider, glider/booster transition section and the booster and to verify the compatibility of specified systems connected across the glider/booster interface.

2.1.1 Test Objectives The objectives of this test are to demonstrate the satisfactory physical connection and alignment of the glider/booster interface and to verify the functional compatibility of subsystems connected across this interface.

2.1.2 Test Configuration Two (2) categories of test are required: 1) physical compatibility; and 2) functional compatibility. The physical compatibility testing requires a structurally complete glider, glider/booster transition, and booster for physical mating and alignment of the vehicle. The functional compatibility test requires the complete structural air vehicle and all subsystems installed that have an interface function. All glider/booster interface connections shall be complete and all interfacing subsystems shall conform to the flight configuration. All explosive items shall be simulated with inert units.

The AGE items required for this test shall be the equipment required for handling of the glider and booster and the equipment required for operation and checkout of the subsystems involved in this test.

2.1.3 Test Conditions The Physical Compatibility Test shall consist of:

1. Observing the handling and assembling processes to evaluate the ability of the handling equipment to assist in joining the sections together with respect to ease of assembly, damage prevention, and safety.

2. Observing the aligning and assembling processes to check out methods of alignment and assembly and to determine that the vehicle is properly assembled and aligned when the process is completed.

3. Checking all electrical connections across the Glider/Booster Interface for continuity and proper routing through connectors.

4. Evaluating the accessibility in the Glider/Booster interface area from an alignment and assembly standpoint.

The functional compatibility test conditions have not been determined. Primary concern will be verification of guidance and control interfacing functions, pilot display interfacing functions, malfunction detection system functions, and flight termination interfacing functions.

2.1.4 Data Requirements Data requirements will be inserted when available.

2.1.5 Report Requirements Progress against test schedules and significant problems shall be reported by the test conductor in status reports. A final report shall be prepared and submitted within one month of test completion.

THE BOEING COMPANY

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TITLE AIR VEHICLE DYNAMIC

Section 2.2

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2.2 AIR VEHICLE DYNAMIC TEST REQUIREMENTS

Program redirection subsequent to the 12-20-61 revision of this document requires a reappraisal of Air Vehicle Dynamic testing. No firm requirements exist at this writing.